DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

Phthalates and Metals in Packaging from Consumer and Children's Products

February 2012

Publication No. 12-07-022

Publication Information

It is Washington State Department of Ecology policy to have an approved Quality Assurance Project Plan for all Agency-sponsored sampling events. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post a report of the study to the Internet.

The plan for this study is available on the Department of Ecology's website at http://www.ecy.wa.gov/biblio/1207022.html.

Author and Contact Information

Alex Stone
P.O. Box 47600
Hazardous Waste and Toxics Reduction Program
Washington State Department of Ecology
Olympia, WA 98504-7600

For more information contact: Communications Consultant, phone 360-407-6834.

Washington State Department of Ecology - www.ecy.wa.gov/

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

Any use of product or firm names in this publication is for descriptive purposes only and does not imply endorsement by the author or the Department of Ecology.

To ask about the availability of this document in a format for the visually impaired, call 360-407-6834.
Persons with hearing loss can call 711 for Washington Relay Service.
Persons with a speech disability can call 877- 833-6341.

Quality Assurance Project Plan

Phthalates and Metals in Packaging from Consumer and Children's Products

February 2012

Approved by:

Signature: ____________________ Date: __________
Joshua Grice, Client, W2R Program

Signature: ____________________ Date: __________
Alex Stone, Author / Client / Project Manager, HWTR-HQ

Signature: ____________________ Date: __________
Samuel Iwenofu, HWTR Quality Assurance Officer

Signature: ____________________ Date: __________
Ken Zarker, Client, HWTR-HQ

Signature: ____________________ Date: __________
Carol Kraege, Client, W2R Program

Signatures are not available on the Internet version.
HWTR-HQ: Hazardous Waste and Toxics Reduction Program
W2R: Waste 2 Resources Program

Table of Contents

List of Figures and Tables

Abstract

The Washington State Department of Ecology's (Ecology) Hazardous Waste and Toxics Reduction (HWTR) and Waste 2 Resources (W2R) Programs are conducting a study to evaluate presence of eight phthalates used as plasticizers and 10 potentially hazardous metals in packaging from products with special emphasis on children's products. The study is being conducted to determine compliance with Washington's Toxics in Packaging Legislation and to evaluate the level of phthalates and some metals in consumer and children's packaging. It is being supported with funding from the Washington State Attorney General's Office.

Phthalates to be tested under this project include:

Phthalate ester	CAS Number
Diethyl phthalate (DEP)	84-66-2
Dibutyl phthalate (DBP)	84-74-2
Di-n-Hexyl Phthalate (DHP)	84-75-3
Butyl Benzyl phthalate (BBP)	85-68-7
Di-2-ethylhexyl phthalate (DEHP)	117-81-7
Di-n-octyl phthalate (DnOP)	117-84-0
Diisodecyl phthalate (DIDP)	26761-40-0
Diisononyl phthalate (DINP)	28553-12-0

Metals in this study include:

Metals	
Antimony	Copper
Arsenic	Lead
Cadmium	Mercury
Chromium	Molybdenum
Cobalt	Zinc

It is Ecology policy to have an approved Quality Assurance Project Plan for all Agency-sponsored sampling events. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion of the study, a report describing the study results will be posted to the Internet.

Background

Metals

In 1991, the Washington State Legislature passed Chapter 70.95G RCW (Packages Containing Metals, 1991) that limits the amount of four toxic metals (mercury, cadmium, lead and hexavalent chromium) in packaging sold in Washington State. Ecology was identified as the responsible agency for implementing this legislation. The Legislation contains a very broad definition for both packaging and packaging components[1]. Packaging is defined as:

> *"Package" means a container providing a means of marketing, protecting, or handling a product and shall include a unit package, an intermediate package, and a shipping container. "Package" also means and includes unsealed receptacles such as carrying cases, crates, cups, pails, rigid foil and other trays, wrappers and wrapping films, bags, and tubs.*

A packaging component is defined as:

> *"Packaging component" means an individual assembled part of a package such as, but not limited to, any interior or exterior blocking, bracing, cushioning, weatherproofing, exterior strapping, coatings, closures, inks, and labels.*

The legislation establishes a limit of 100 ppm for the total concentration of all four metals. Ecology does not have any penalty authority under the legislation but may ban the sale of any product that does not meet the regulated levels if a company refuses to comply.

In 2007, Ecology joined the Toxics in Packaging Clearinghouse (TPCH), an association of 10 states with similar legislation[2]. The TPCH has facilitated education and outreach to businesses on toxics in packaging requirements and has conducted several sampling events to emphasize the need for compliance with packaging legislation. Individual states have also conducted packaging sampling to guarantee compliance.

Six metals (molybdenum, arsenic, cobalt, mercury, cadmium and antimony) were identified as Chemicals of High Concern to Children (CHCCs) as defined by the Children's Safe Product Act (CSPA). While the CSPA does not require reporting on the presence of chemicals in packaging, the metals identified as CHCCs are of interest for this study. (See Appendix B for the list of CHCCs identified in the CSPA.)

The metals identified as CHCCs have been found to cause cancer (antimony, arsenic, cadmium, cobalt) and developmental impacts (molybdenum, arsenic, cadmium, cobalt and mercury). (DOH, 2010) In addition, they have been found or likely to be found in children's products, which was required before they could be identified as a CHCC.

---

[1] 70.95G.010, accessed 1/23/2012.
[2] Toxics in Packaging Clearinghouse website available at: http://www.toxicsinpackaging.org/, accessed 1/23/2012.

Two additional metals (copper and zinc) are also being analyzed in packaging from children's products. Copper and zinc have been identified as potentially having a major impact upon the Puget Sound (Ecology 2011). Concerns have been raised about the use of these metals in packaging and consumer products as a potential source to the Puget Sound.

Copper and zinc are toxic to aquatic species and particularly the development of fish. As indicated in a report from the US Fish and Wildlife Services:

> *Mixtures of zinc and copper are generally acknowledged to be more-than-additive in toxicity to a wide variety of aquatic organisms*…'

The aquatic organisms impacted by zinc and copper include oysters and both marine and freshwater fish among others. (Eisler, 1993)

Phthalates

Phthalates are a class of chemicals added to improve the flexibility of plastics for a wide variety of uses. Phthalates are also used as solubilizing and stabilizing agents in other applications. Phthalates are used in a wide range of products including: adhesives, automotive plastics, detergents, lubricating oils, some medical devices and pharmaceuticals, plastic raincoats, solvents, vinyl tiles and flooring, and personal-care products, such as soap, shampoo, deodorants, lotions, fragrances, hair spray, and nail polish. Phthalates are often used in polyvinyl chloride type plastics, such as plastic bags, garden hoses, inflatable recreational toys, blood product storage bags, intravenous medical tubing, and toys (CDC, 2009).

As phthalates are not chemically bonded to the plastic, phthalates can be released directly to the environment. People can be exposed to phthalates through direct contact, through ingestion or through breathing of air contaminated with phthalates. Generally, phthalates are metabolized and excreted quickly and do not accumulate in the body (Anderson et al., 2001). The Center for Disease Control and Prevention (CDC) found phthalates in most samples in its recent evaluation of toxic chemicals in humans. (CDC, 2009)

Eight phthalates and the phthalate precursor, phthalic anhydride, were identified as CHCCs in Ecology's rule to implement the CSPA. Of the eight phthalates, DEHP has been identified as causing cancer. All have been identified as having negative impacts on reproductivity, development or other systemic impacts. (DOH, 2010) In addition, DEHP has been identified as potentially having a major impact upon the Puget Sound. (Ecology, 2011)

Project Description

Ecology's HWTR and W2R Programs will conduct a study to measure ten metals (see Table 1 for a list of the metals involved) and eight phthalates (Table 2) in packaging with special emphasis on packaging from children's products. The objective of the study will be to determine compliance with the state's toxics in packaging legislation and to assess the levels of metals and phthalates in packaging from children's products. Packaging is currently not covered by the Children's Safe Product Act and information from this study will help to quantify whether packaging of children's products poses a potential risk to children.

Packaging will be collected and screened for metals with a portable XRF analyzer during the spring of 2012. Those samples found to contain sufficient metals of interest will be sent to Manchester Environmental Laboratory for analysis. Samples containing phthalates will be sent to a contract laboratory for analysis.

Sampling Process Design (Experimental Design)

Approximately 200 packaging samples from general and children's products will be gathered for testing. Packaging retained from children's products purchased for projects detailed in other QAPPs will be considered for analysis. Additional packaging samples will be purchased or obtained from local stores and internet retailers for testing. Emphasis will be placed upon packaging from inexpensive stores and children's products packaged in soft plastics, which are more likely to contain phthalates.

All packaging samples will be screened with a portable XRF for the metals of concern to determine if laboratory analysis is necessary. It is anticipated that approximately 125 packaging samples will be forwarded for metals analysis. As an XRF cannot detect phthalates, information on the label, the type of plastic used and other potential sources of information will be used to determine whether a packaging sample is likely to contain phthalates.

Items will be sent to the laboratory if they violate screening criteria (outlined below) during the XRF analysis or are selected for low level analysis. Laboratory analysis will be completed by inductively coupled plasma mass spectroscopy (ICP-MS) (metals), cold vapor atomic absorption (CVAA) (mercury), and gas chromatography-mass spectroscopy (GC/MS) (phthalates).

Packaging Selection

Consumer products selected for analysis will focus on specific types of packaging found by the TPCH to be an on-going issue including but not restricted to, soft vinyl plastic, certain dyes and inks, etc. Children's packaging selected for analysis will focus on packaging and packaging elements from products that are most likely to be mouthed or used by children under three. For instance, bags or cases that are designed to be used as part of the product, or are able to be reused separately from the product, will be of greatest interest. Packaging elements that are intended to be discarded but could be put into a child's mouth will also be of particular interest.

Packaging Screening

Packaging will be screened using a portable XRF gun following the XRF manufacturer's recommendations and adaptations of ASTM method F 2617-08 *Standard Test Method for Identification and Quantification of Chromium, Bromine, Cadmium, Mercury, and Lead in Polymeric Material Using Energy Dispersive X-ray Spectrometry*. While ASTM method F 2617-08 is not intended for samples with surface coatings or non-polymeric materials, all samples will be screened following adaptations of the method for qualitative information.

Target Chemicals

Target chemicals proposed for testing along with state and federal criteria are shown in Table 1 and the list of specific phthalate esters included in this study is found in Table 2.

Table 1. State and Federal Criteria for Analytes of Interest.

Analytes	Action levels (ppm)	
	State[=]	Federal
Phthalates	5.0	6,000[a]
Antimony	1.0	60[^]
Arsenic	1.0	25[^]
Cadmium	1.0	75[^]
Chromium	1.0	
Cobalt	1.0	-
Copper	-	
Lead	-	90[+]
Mercury	0.5	60[^]
Molybdenum	1.0	-
Zinc	-	

[=] State Limit: Draft practical quantitation limits as defined in the CSPA Rule Reporting Guidance, available at: http://www.ecy.wa.gov/programs/swfa/cspa/pdf/cspaguide_pql.pdf, accessed 1/3/2012.
[a] Consumer Products Safety Improvement Act, establishes a total of 1,000 ppm for each of six phthalates, available at: http://www.cpsc.gov/about/cpsia/faq/108faq.html#108q7, accessed 1/24/2012.
[^] Federal Limit: ASTM F963-07, Maximum allowable amounts in surface coatings of toys.
[+] Federal Limit: 16 C. F. R. 1303 restrictions in surface coatings of consumer goods and children's products. Non-soluble portions are limited to 100 ppm in August 2011.

Table 2. Specific Phthalate Esters Included in the Study.

Phthalate	CAS Number
Diethyl phthalate (DEP)	84-66-2
Dibutyl phthalate (DBP)	84-74-2
Di-n-Hexyl Phthalate (DHP)	84-75-3
Butyl Benzyl phthalate (BBP)	85-68-7
Di-2-ethylhexyl phthalate (DEHP)	117-81-7
Di-n-octyl phthalate (DnOP)	117-84-0
Diisodecyl phthalate (DIDP)	26761-40-0
Diisononyl phthalate (DINP)	28553-12-0

For screening purposes, packaging containing half or more of the state action levels in Table 1 will be forwarded to the laboratory for validation (to the limits of the laboratory budget). It should be noted, criteria under ASTM F963-07 and 16 C.F.R. § 1303 are designed for soluble portions of surface coatings. XRF screening, however, provides results for total metals. In the instance of more detectable levels of metal than the budget will allow, those packaging samples with the highest concentrations will be sent to the laboratory for additional analysis.

All 10 metals will be analyzed in each sample forwarded to the laboratory if screening levels for a single metal are violated. In addition to packaging that exceeds the screening levels, multiple samples containing low levels will be forwarded to the laboratory for analysis.

As with metals, samples containing the highest levels of phthalates determined from available information such as labels, product databases and other readily-available information will be sent to the laboratory for analysis. The exact number of samples will depend upon the availability of applicable packaging and budgetary constraints.

Organization and Schedule

Table 3 lists the individuals involved in the project and Table 4 contains a schedule.

Table 3. Organization of Project Staff and Responsibilities.

Staff	Title	Responsibilities
Carol Kraege, W2R (360) 407-6906	Client	Reviews project scope and budget, tracks progress, reviews draft QAPP and approves final QAPP.
Ken Zarker, HWTR-HQ (360) 407-6698	Client	Reviews project scope and budget, tracks progress, reviews draft QAPP and approves final QAPP.
Joshua Grice, W2R (360) 407-6786	Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Alex Stone HWTR-HQ Program (360) 407-6758	Project Manager	Writes QAPP, oversees field sampling and transportation of samples to laboratory. Conducts QA review of data, analyzes and interprets data. Writes draft report and final report.
Samuel Iwenofu HWTR-SWRO (360) 407-6964	HWTR QA Officer	Reviews draft QAPP and approves final QAPP.

HWTR-HQ: Hazardous Waste and Toxics Reduction Program-Headquarters.
HWTR-SWRO: Hazardous Waste and Toxics Reduction Program-Southwest Regional Office
QAPP: Quality Assurance Project Plan.
W2R: Waste 2 Resources.

Table 4. Proposed Schedule for Completing Field and Laboratory Work and Reports.

Field and laboratory work	Due date	Lead staff
Field work completed	March 2012	Alex Stone
Laboratory analyses completed	June 2012	
Final report		
Author lead / Support staff	Alex Stone	
Schedule		
Draft due to supervisor	September 2012	
Draft due to client/peer reviewer	October 2012	
Final (all reviews done)	November 2012	

Final report due on web	January 2013

Sample Collection and Preparation

Products will be obtained in person or through internet retailers by HWTR or W2R staff. In addition, packaging reserved from other Ecology sampling events will be evaluated to determine if they meet the requirements of this QAPP.

Upon collection, products will be removed from their original packaging using pre-cleaned stainless steel implements. The packaging used to contain the product will be screened for metals. Those samples to be sent for both metals and phthalates analysis will be divided in half for possible shipment to different laboratories.

The samples will be screened for metals using a portable XRF. Packages that contain appreciable levels of metals will be sent to Manchester laboratory for analysis, where possible. If Manchester is unable to meet the QAPP requirements, the same procedure used for phthalate analysis will be used to obtain a contract laboratory to conduct the sample analysis.

Packaging samples will be sent to a contract laboratory for phthalate analysis. Laboratories under contract to the state to provide analytical data (State Contract 1807) will first be approached for analytical support. If no laboratory can conduct the analyses under the state contract, the Project Manager will solicit qualified laboratories to provide analytical services. The Project Manager will be responsible for the review and evaluation of all laboratory analysis.

Photos and descriptive notes on each product screened such as approximate thickness, surface roughness, material makeup, etc. will be recorded. Other information such as the type of advertisement used to sell the product, where in the store the product was located, etc. may be necessary to prove the product was intended for children.

All field and laboratory staff handling the items will wear powder free nitrile gloves. Stainless steel tools used to deconstruct the product or remove it from its packaging along with the mortar and pestle will be cleaned by the following sequence: hot water scrub with liquinox soap, 10% nitric acid rinse, deionized water rinse, acetone rinse, and hexane rinse.

Analytical Procedures

XRF Analysis

Individual components of packaging will be screened using a Niton XL3t portable XRF gun (Figure 1) or equivalent following the manufacturers recommendations and adaptations of ASTM method F 2617-08 *Standard Test Method for Identification and Quantification of Chromium, Bromine, Cadmium, Mercury, and Lead in Polymeric Material Using Energy Dispersive X-ray Spectrometry*. The W2R program is currently in the process of purchasing an XRF instrument. Actual instrument details may vary depending upon the Model and Company selected from the bidding process.

For the initial screening, a reading will be taken for at least 30 seconds on a smooth (or near smooth) area of the packaging large enough to cover the spectrometer's window and at least 2 mm thick. If the item is less than 2 mm thick, it may be folded on to itself until 2 mm depth has been reached (care will be taken to trap minimal air in between folds).

Figure 1. Niton Portable XRF

If the screening measurement violates screening criteria, a second longer measurement will be taken (up to 180 seconds). Both measurements will be taken using the appropriate XRF software package (based on sample material). Detection limits are shown in Table 5. After XRF analyses are completed, samples will be placed in pre-cleaned I-Chem jars and forwarded to the appropriate laboratory for testing.

Table 5. Niton Portable XRF LOQs and Expected Range of Results.

Element	Expected Range of Results (ppm)	LOQ (ppm)$^{+}$
Antimony	<LOQ - 300	25
Arsenic	<LOQ - 300	3
Cadmium	<LOQ - 300	15
Chromium	<LOQ - 300	*
Cobalt	<LOQ - 300	15
Copper	<LOQ - 300	15
Lead	<LOQ - 300	4
Mercury	<LOQ - 10	6
Molybdenum	<LOQ - 300	*
Zinc	<LOQ - 300	15

ppm = parts per million
LOQ = Limit of Quantitation
[+] Polyethylene blank, 8 mm aperture, 180 second total analysis time
[*] Detection limits are not specified by the manufacturer for these elements

All samples screened will be assigned a unique identifier and results from the XRF will be transferred to Microsoft Excel spreadsheets.

Laboratory

Table 6 describes digestion and analysis methods along with estimated LOQ's. Metals samples will be prepared following EPA 3052 (microwave complete digestion) and measured using ICP-MS or CVAA (mercury).

Phthalates will be measured by a contract laboratory using GS-MS. Sample extraction and analysis methods used by the contract laboratory will be approved by the Project Manager.

Table 6 Laboratory Methods and Reporting Limits

Analyte	Digestion Method	Instrumentation	Method	RL (ppm)
Antimony	EPA 3052	ICP-MS	EPA 6020	1.0
Arsenic	EPA 3052	ICP-MS	EPA 6020	1.0
Cadmium	EPA 3052	ICP-MS	EPA 6020	1.0
Cobalt	EPA 3052	ICP-MS	EPA 6020	1.0
Copper	EPA 3052	ICP-MS	EPA 6020	1.0
Lead	EPA 3052	ICP-MS	EPA 6020	1.0
Molybdenum	EPA 3052	ICP-MS	EPA 6020	1.0
Mercury	EPA 3052	ICP-MS	EPA 6020	0.1
Zinc	EPA 3052	ICP-MS	EPA 6020	1.0
Phthalates	*	GC-MS	*	5.0

ICP-MS = Inductively-coupled plasma/mass spectrometry
CV AA = Cold vapor atomic absorption
GC-MS = Gas chromatography/mass spectroscopy
RL = Reporting Limit
* Method will be approved by Project Manager

Budget

The project budget is included in Table 7.

Table 7. Project Budget

	# of Samples	Cost per sample	Total
New Samples	150	$5.00	$750.00
Metals	100	$200.00	$20,000.00
Phthalates	125	$350.00	$43,750.00
Total			**$65,000.00**

Quality Objectives

Quality objectives for this project are to obtain data of sufficient quality so that the amount of metals and phthalates in packaging from general and children's products can be determined. These objectives will be achieved through careful attention to the sampling, sample processing, measurement, and quality control (QC) procedures described in this plan.

Measurement Quality Objectives

An XRF reading will be taken every 25 samples on standards provided by the manufacturer. Since the XRF analysis is being used as a screening tool only, no measurement quality objectives (MQOs) are outlined. Performance of the portable XRF has been determined in a previous EAP report (Publication No. 12-03-009), which proves the efficacy of using an XRF as a screening tool particularly for metals. The conclusions from the previous report will be implemented in this work and all screening will be done using a stand to minimize error.

MQOs for laboratory analysis of metals and phthalates are shown in Table 8. It is expected that MEL and contract laboratories will meet these criteria. MQOs falling outside of the acceptance limits will be reviewed by the Project Manager for their usability.

Table 8. MQOs for Laboratory Analyses.

	Laboratory Control Samples	**Matrix Spikes**	**Duplicates**[+]	**Method Blanks***
	(recovery)	(recovery)	(RPD)	(ppm)
Antimony	85- 115%	75-125%	±20%	1.0
Arsenic	85- 115%	75-125%	±20%	1.0
Cadmium	85- 115%	75-125%	±20%	1.0
Cobalt	85- 115%	75-125%	±20%	1.0
Copper	85- 115%	75-125%	±20%	1.0
Lead	85- 115%	75-125%	±20%	1.0
Mercury	85- 115%	75-125%	±20%	0.1
Molybdenum	85- 115%	75-125%	±20%	1.0
Zinc	85- 115%	75-125%	±20%	1.0
Phthalates	70- 130%	70-130%	±20%	30.0

[*] Metals reporting limits were established by raising soil limits by a factor of 10
[+] Matrix spike duplicates and split duplicates
RPD – Relative Percent Difference
ppm = parts per million

Quality Control Procedures

Field

No field quality control procedures are anticipated for this project.

Laboratory

Table 9 shows laboratory QC samples planned for the project. Split duplicate samples will be used to assess variability in the data due to sample preparation and laboratory procedures.

Table 9. Quality Control Tests.

	Laboratory Control Samples	Matrix Spikes	Matrix Spike Duplicates	Laboratory Duplicates	Split Duplicates†	Method Blanks	Surrogate Recovery*
Elements	1/batch	1/batch	1/batch	1/batch	1/batch	1/batch	every sample

† Dependent on amount of sample available

* PBDEs only

Data Management Procedures

XRF data from the screening portion of the project will be transferred to Microsoft Excel spreadsheets and stored with the Project Manager.

Data packages from MEL and any lab contracted for sample analysis will include case narratives discussing any problems encountered with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. The narrative should address condition of the samples on receipt, sample preparation, methods of analysis, instrument calibration, recovery data, and results on QC samples. This information is needed to evaluate the accuracy of the data and to determine whether the MQOs were met.

Audits

MEL and any lab contracted for sample analysis must participate in performance and system audits of their routine procedures. Results of these audits must be made available on request.

Report

A final report detailing the findings of the study will be completed. The final report will include:

- Categorical descriptions of the packaging screened with the portable XRF (brands, product names, etc. will not be included)
- Comparison of laboratory results with XRF screenings, where applicable.
- Assessment of packaging test results from children's products for metals and phthalates.

- Determination of whether significant levels of phthalates are found in children's packaging.
- Data on specific packaging and packaging components from children's products and whether they the levels of metals found would violate standards in the toxics in packaging legislation.

Data Verification

The Project Manager will conduct a review of all laboratory data generated by MEL and contract laboratories. The Project Manager will verify that methods and protocols specified in this QAPP were followed, that all calibrations, checks on quality control, and intermediate calculations were performed for all samples, and that the data are consistent, correct, and complete, with no errors or omissions. Evaluation criteria will include the acceptability of procedural blanks, calibration, matrix spike recoveries, labeled compound and internal standard recoveries, ion abundance ratios, duplicates, laboratory control samples, and appropriateness of data qualifiers assigned.

A case narrative will meet the requirements for a data verification report for MEL's chemical data.

Data Quality (Usability) Assessment

The Project Manager will examine the data reviews, case narratives, and data packages to assess the usability of the data. To determine if project MQOs have been met, results for laboratory control samples, sample duplicates, matrix spikes, and labeled compound recoveries will be compared to QC limits. The method blank results will be examined to verify there was no significant contamination of the samples. To evaluate whether the targets for reporting limits have been met, the results will be examined for "non-detects" and to determine if any values exceed the lowest concentration of interest. Based on these assessments, the data will be either accepted, accepted with appropriate qualifications, or rejected and re-analysis considered.

References

American Society for Testing and Materials (ASTM), 2008. F 2617-08 Standard Test Method for Identification and Quantification of Chromium, Bromine, Cadmium, Mercury, and Lead in Polymeric Material Using Energy Dispersive X-Ray Spectrometry.

Anderson, W.A., L. Castle, M. J. Scotter, R. C. Massey and C. Springall. 2001. *A biomarker approach to measuring human dietary exposure to certain phthalate diesters*. **Food Addit Contam**, 18, pages 1068-1074.

Centers for Disease Control and Prevention, 2009. Fourth National Report on Human Exposure to Environmental Contaminants. http://www.cdc.gov/exposurereport/pdf/FourthReport.pdf

Children's Safe Product Act, 2008. Chapter 70.240 RCW, available at: http://apps.leg.wa.gov/rcw/default.aspx?cite=70.240&full=true, accessed 1/23/2012.

CPSC, 2007. Lead Testing by XRF Frequently Asked Questions. Business memo. Accessed 12/2010. http://www.cpsc.gov/businfo/xrffaq.pdf

Ecology 2011. Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in the Puget Sound Basin, 2007-2011. Accessed 1/26/12. http://www.ecy.wa.gov/biblio/1103055.html

Eisler, Ronald, 1993. Zinc Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U. S. Department of the Interior Fish and Wildlife Service, 126 pages. Available at: http://www.pwrc.usgs.gov/infobase/eisler/chr_26_zinc.pdf, accessed 1/23/2012.

Herrera Environmental Consultants, Inc., 2009. Recalculated Loading Rates by Land Use: Addendum 2 to the Phase 2 Toxics Loading Report, available at: http://www.ecy.wa.gov/biblio/0810084addendum2.html, accessed 1/23/2012.

Packaging Containing Metals, 1991. Chapter 70.95G RCW, available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.95G&full=true, accessed 1/23/2012.

Stone, Alex and Damon Delistraty, 2010, 'Sources of toxicity and exposure information for identifying chemicals of high concern to children', **Env. Impact Assess. Review**, 30, pages 380–387.

United States Food and Drug Administration (USFDA), Phthalate website at: http://www.fda.gov/cosmetics/productandingredientsafety/selectedcosmeticingredients/ucm128042.htm, accessed 1/3/2012.

Washington Department of Health (DOH), 2010. *Rationale for Reporting List of Chemicals of High Concern to Children Prepared by the Washington State Department of Health for the Children's Safe Product Act*, available at: http://www.ecy.wa.gov/programs/swfa/rules/pdf/p1text.pdf, accessed 1/3/2012.

Appendices

Appendix A. Chemicals required by the CSPA rule to be reported in children's products.

CAS	Chemical
50-00-0	Formaldehyde
62-53-3	Aniline
62-75-9	N-Nitrosodimethylamine
71-36-3	n-Butanol
71-43-2	Benzene
75-01-4	Vinyl chloride
75-07-0	Acetaldehyde
75-09-2	Methylene chloride
75-15-0	Carbon disulfide
78-93-3	Methyl ethyl ketone
79-34-5	1,1,2,2-Tetrachloroethane
79-94-7	Tetrabromobisphenol A
80-05-7	Bisphenol A
84-66-2	Diethyl phthalate
84-74-2	Dibutyl phthalate (DBP)
84-75-3	Di-n-Hexyl Phthalate
85-44-9	Phthalic Anhydride
85-68-7	Butyl Benzyl phthalate (BBP)
86-30-6	N-Nitrosodiphenylamine
87-68-3	Hexachlorobutadiene
94-13-3	Propyl phthalate
94-26-8	Butyl phthalate
95-53-4	2-Aminotoluene
95-80-7	2,4-Diaminotoluene
99-76-3	Methyl phthalate
99-96-7	p-Hydroxybenzoic acid
100-41-4	Ethylbenzene
100-42-5	Styrene
104-40-5	4-Nonylphenol; 4-NP and its isomer mixtures including CAS 84852-15-3 and CAS 25154-52-3
106-47-8	para-Chloroaniline
107-13-1	Acrylonitrile
107-21-1	Ethylene glycol
108-88-3	Toluene
108-95-2	Phenol
109-86-4	2-Methoxyethanol
110-80-5	Ethylene glycol monoethyl ester

CAS	Chemical
115-96-8	Tris(2-chloroethyl) phosphate
117-81-7	Di-2-ethylhexyl phthalate (DEHP)
117-84-0	di-n-octyl phthalate (DnOP)
118-74-1	Hexachlorobenzene
119-93-7	3,3'-Dimethylbenzidine and Dyes Metabolized to 3,3'-Dimethylbenzidine
120-47-8	Ethyl phthalate
123-91-1	1,4-Dioxane
127-18-4	Perchloroethylene
131-55-5	Benzophenone-2 (Bp-2); 2,2',4,4'-Tetrahydroxybenzophenone
140-66-9	4-tert-Octylphenol; 1,1,3,3-Tetramethyl-4-butylphenol
140-67-0	Estragole
149-57-5	2-Ethylhexanoic Acid
556-67-2	Octamethylcyclotetrasiloxane
608-93-5	Benzene, pentachloro
842-07-9	C.I. Solvent Yellow 14
872-50-4	N-Methylpyrrolidone
1163-19-5	2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether; BDE-209
1763-23-1	Perfluorooctanyl sulphonic acid and its salts; PFOS
1806-26-4	Phenol, 4-octyl-
5466-77-3	2-Ethyl-hexyl-4-methoxycinnamate
7439-97-6	Mercury & mercury compounds including methyl mercury (22967-92-6)
7439-98-7	Molybdenum & molybdenum compounds
7440-36-0	Antimony & Antimony compounds
7440-38-2	Arsenic & Arsenic compounds including arsenic trioxide (1327-53-3) & dimethyl arsenic (75-60-5)
7440-43-9	Cadmium & cadmium compounds
7440-48-4	Cobalt & cobalt compounds
25013-16-5	Butylated hydroxyanisole; BHA
25154-52-3	Nonylphenol
25637-99-4	Hexabromocyclododecane
26761-40-0	Diisodecyl phthalate (DIDP)
28553-12-0	Diisononyl phthalate (DINP)

Appendix B. Glossary, Acronyms, and Abbreviations

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

CDC	Center for Disease Control and Prevention
CHCC	Chemicals of High Concern to Children
e. g.	For example
Ecology	Washington State Department of Ecology
et al.	And others
HQ	Headquarters
HWTR	Hazardous Waste and Toxics Reduction Program
i. e.	In other words
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
PBT	persistent, bioaccumulative, and toxic substance
QA	Quality assurance
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SRM	Standard reference materials
SWRO	Southwest Regional Office
W2R	Waste 2 Resources Program

Units of Measurement

ng	nanogram, equal to one millionth of a gram
mg	milligram, equal to one thousandth of a gram
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
mm	millimeter, equal to one thousandth of a meter
meter	meter, a unit of distance
mL	milliliter, equal to one thousandth of a liter
Liter	liter, a unit of volume
ppm	parts per million
mg/kg	milligrams per kilogram (parts per million)
ng/g	nanograms per gram (parts per billion)
ng/kg	nanograms per kilogram (parts per trillion)
mg/L	milligrams per Liter (parts per million)
ng/L	nanograms per Liter (parts per trillion)
s.u.	standard units