NOTICE

The United States Government and the state of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. TX -99/7-4974-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Environmental Characteristics of Traditional Construction and Maintenance Materials: Final Report		5. Report Date February 2001 6. Performing Organization Code TechMRT
7. Author(s) Audra Morse, Phillip T. Nash, Sanjaya Senadheera, Andrew Jackson, Richard Wm. Tock, Jeremy Leggoe, and Tony Mollhagen		8. Performing Organization Report No. 4974-1
9. Performing Organization Name and Address Texas Tech University Center for Multidisciplinary Research in Transportation Box 41023 Lubbock, Texas 79409-1023		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project 7-4974
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology P. O. Box 5080 Austin, TX 78763-5080		13. Type of Report and Period Cover Final Report 14. Sponsoring Agency Code

15. Supplementary Notes
Study conducted in cooperation with the Texas Department of Transportation.
Research Project Title: "Environmental Assessment of Traditional Construction and Maintenance Materials"

16. Abstract

The purpose of this report is to document the findings of project number 7-4974, Environmental Assessment of Traditional Construction and Maintenance Materials. For the purpose of this report, traditional construction and maintenance materials include cement, fly ash, lime, aggregate, bituminous binders, bottom ash, RAP, and RCP, which have been used in TxDOT projects for many years. Leachate from components of construction and maintenance materials such as cement, aggregate, and bituminous binders were analyzed to determine the concentration of contaminants that would be released into the environment. The analytical results were compared to RRS2 as specified in DMS 11000. As part of this project, recommendations were made regarding environmental standards for recycled materials. One recommendation is that recycled material metal concentration should be equivalent to the RRS2 value or the average detected value plus one standard deviation for the material the recycled material is replacing.

17. Key Words traditional materials, RCP, RAP, asphalt, fly ash, lime, aggregate, leaching procedure, semi-volatile organics, Portland cement, LRA	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 180	22. Price

Form DOT F 1700.7 (8-72)

Environmental Characteristics of Traditional Construction and Maintenance Materials

By

Audra Morse, E.I.T.
Research Associate

Phillip T. Nash, P.E.
Research Supervisor

Sanjaya Senadheera,, Ph.D
Andrew Jackson, Ph.D
Richard Wm. Tock, Ph.D
Jeremy Leggoe, Ph.D
Tony Mollhagen, Ph.D.

Final Report
Project Number: 7-4974
Report Number: 4974-1

Research Sponsor:
Texas Department of Transportation

Texas Tech University
Department of Civil Engineering
Box 41023
Lubbock, TX 79409-1023

February, 2001

IMPLEMENTATION STATEMENT

This project delivered several products useful to the department. Specifications for each traditional material were developed and may be used as a benchmark value against which non-traditional materials may be measured. Research findings of this project can be used to evaluate the environmental suitability of construction materials.

A summary of information regarding the environmental suitability of the traditional materials was documented through a literature search and contact with other transportation agencies. The summary includes regulations and requirements from eight other states.

Prepared in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

AUTHOR'S DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view of policies of the Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PATENT DISCLAIMER

There was no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new useful improvement thereof, or any variety of plant which is or may be patentable under the patent laws of the United States of America or any foreign country.

ENGINEERING DISCLAIMER

Not intended for construction, bidding, or permit purposes.

TRADE NAMES AND MANUFACTURERS' NAMES

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3.				
	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
	ILLUMINATION			
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE and PRESSURE or STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
	TEMPERATURE (exact)			
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE and PRESSURE or STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate

(Revised September 1993)

TABLE OF CONTENTS

Disclaimers	vii
Metric Conversion Table	viii
Table of Contents	ix
List of Tables	x
List of Figures	xi
Introduction	1
Literature Review and State Regulation Study	2
Sampling Plan	17
Testing of Sampled Materials	24
Testing Results	31
Discussion	41
Recommendations	48
Conclusion	53
Work Cited	54

Appendix A: The Results of Metal Analysis and Organic Compound Analysis Identified in the Literature Survey	A-1
Appendix B: Results of the Metal Analysis and Semi-Volatile Organic Compound Analysis are shown in the following tables	B-1
Appendix C: A sample log is shown in the following table	C-1

LIST OF TABLES

Table 1. Summary of Literature Review for Cement Metal Analysis 3
Table 2. Summary of Literature Review for Bituminous Binder Metal Analysis 5
Table 3. Summary of Literature of Organic Analysis of Bituminous Binder Leachate 6
Table 4. Summary of Literature Review for RAP Metal Analysis 7
Table 5. Summary of Literature of Organic Analysis of RAP Leachate 8
Table 6. Summary of Leachate Test from the Literature Review for Coal Fly Ash Metal Analysis 12
Table 7. Summary of Groundwater and Runoff Analyses from the Literature Review for Coal Fly Ash Metal Analysis 13
Table 8. Metals 17
Table 9. Semi-Volatile Organic Compounds 18
Table 10. RRS2 Values (30 TAC 335, Subchapter S) 31
Table 11. Results for Limestone 32
Table 12. Results for Siliceous Gravel 32
Table 13. Results for Sandstone 32
Table 14. Results for Siliceous Sand 33
Table 15. Results for Caliche 33
Table 16. Results for LRA 33
Table 17. Results for Class F Fly Ash 34
Table 18. Results for Class C Fly Ash 34
Table 19. Results for Cement, Type I 34
Table 20. Results for Cement, Type II 35
Table 21. Results for Cement, Type I/II 35
Table 22. Results for Lime, Type A 35
Table 23. Results for Lime, Type B 36
Table 24. Results for Lime, Type C 36
Table 25. Results for Bottom Ash 36
Table 26. Results for RCP 36
Table 27. Results for RAP 37
Table 28. Results for PCC 38
Table 29. Results for PCC with Fly Ash 38
Table 30. Results for PCC with RCP 39
Table 31. Results for Semi-VOCs in Bituminous Binders 39
Table 32. Results for Semi-VOCs in MC-30's 40
Table 33. Metal Concentrations and Regulatory Standards 42
Table 34. Average Metal Concentrations and Regulatory Standards 43
Table 35. Metal Concentrations and Regulatory Standards 45
Table 36. Semi-VOC Concentrations in Bituminous Binder Samples 46
Table 37. Recommended Values for Aggregate 49
Table 38. Recommended Values for Cement 49
Table 39. Recommended Values for Lime 50
Table 40. Recommended Values for Bottom Ash 50
Table 41. Recommended Values for Fly Ash 51
Table 42. Recommended Values for RCP 51

LIST OF FIGURES

Figure 1. Extraction Vessel and Tumbler 25
Figure 2. Pressure Filtration Device 25
Figure 3. Flame Atomic Absorption Spectrometer 28
Figure 4. Graphite Furnace Atomic Absorption Spectrometer 29

INTRODUCTION

For many decades, traditional construction and maintenance materials used in the Texas Department of Transportations (TxDOT) daily operation have been used with little regard to the environmental impacts of using these materials. Traditional construction and maintenance materials include asphalt, Portland cement concrete, many types of aggregate, lime and other construction materials. However, since the enactment of laws such as the Clean Water Act, National Environmental Protection Act, Solid Waste Management Act, and many others, the public has become environmentally conscious of the impacts our day-to-day life has on the natural resources on this planet. Most importantly, our day-to-day activities must conform to the environmental policy set forth in these regulatory documents.

TxDOT, as well as many other governmental agencies and private industries, are trying to do the three R's—reduce, reuse and recycle. TxDOT has a recycling and recycled products program, which encourages the use of recycled material into TxDOT's construction and maintenance operations. However, non-hazardous recycled materials (NRMs) have been held to strict environmental standards while traditional materials have been exempt from environmental regulation (TxDOT, 2000). This practice is unfair to recycled materials. Traditional materials are exempt from review only because they have been used longer. Thus, the purpose of this research is to develop a baseline using traditional materials to which NRMs may be compared. These standards will be based on the environmental specifications of traditional materials as well as 30 TAC 335, Subchapter S and 30 TAC 350, regarding the Texas Risk Reduction Standards.

The tasks in this project include a literature survey to identify studies that have analyzed the environmental impacts of traditional materials as well as to identify states with regulations pertaining to the use of traditional materials. A sampling plan was developed to determine the materials to be tested, the sources of the materials, and the parameters and constituents to be analyzed in leachate samples. A comparison was performed between the concentrations of the compounds in the leachate and various regulatory standards. This information was used to develop recommendations for draft specifications.

LITERATURE REVIEW AND STATE REGULATION STUDY

The purpose of the literature review was to identify previously completed work assessing the environmental impacts of traditional materials. A literature survey was completed using the Texas Tech Library database and electronic databases (such as FirstSearch and EI Village) available through the Texas Tech Library system for all traditional materials evaluated in this study. The Transportation Research Information System (TRIS) database was searched for studies evaluating the environmental acceptability of concrete and asphalt. The environmental suitability investigation for the materials of interest was divided into four components including manufacture, storage, and construction as well as the roadside environment. These represent the four stages at which the environmental impacts from the material should be considered due to environmental exposure.

The literature review contains three sections. First, the results of the literature survey are presented for the materials investigated in this study. Secondly, the results of phone conversations with other states' environmental and DOT offices are presented. Lastly, the results of the TxDOT district survey, which was used to determine material suppliers, is presented.

Literature Survey

A summary of the results of the literature review for each material investigated is described below. Tables document the results provided by researches sited in the literature if the results were included. The abbreviation NA, not applicable, applies to situations in which the information is not provided or the metal was not investigated.

Portland Cement

Very little information was identified concerning the environmental suitability of cement. However, a study by the Portland Cement Association (PCA) (PCA, 1992) analyzed cement for trace metals. The amount of leachable metals in each sample was evaluated using the U.S. Environmental Protection Agency Toxicity Characteristic Leaching Procedure (TCLP). Cement samples were obtained from 79 cement plants in the United States and 10 cement plants in Canada. Samples were analyzed for eight "RCRA metals" regulated in 40CFR261.24 including arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. Other metals evaluated are thallium, antimony, nickel, and beryllium. None of the cement samples exceeded the RCRA limits for any metal, suggesting the cements analyzed are not hazardous. A detailed review of metal analysis performed on cement is provided in Table 1. For additional information, please refer to Appendix A.

Kreich (1991) tested the suitability of using Portland cement concrete (PCC) obtained from the roadway as clean fill. Polynuclear aromatic hydrocarbons (PAHs) and heavy metals (barium, cadmium, chromium, lead, silver, arsenic, selenium and mercury) were analyzed in the concrete samples. The road sample section was part of Route #4 located south of Springfield, Illinois, and the pavement was built in 1976. Samples were taken between the wheel paths, in the other wheel path, outside the outer wheel path, and from the shoulder. Laboratory samples were prepared by the Illinois Department of Transportation (IDOT) to use as controls. The TCLP and other EPA approved test methods were used in this study.

Samples from the PCC section contained trace amounts of naphthalene and phenanthrene, and one wheel path had measurable levels of barium. Soil samples from the PCC shoulder contained no measurable PAHs, but a measurable level of barium was detected. However, barium was detected in the laboratory sample and the field sample, suggesting aggregate may be the source of barium. The study indicated that PCC pavements have low leachable metals and PAH material.

Kriech (1992a) investigated the suitability of using PCC in clean fill applications. Leachate from the PCC samples was generated using the TCLP procedure. The leachate was analyzed for metals; however, the leachate contained only small amounts of leachable chromium.

Tests examining Portland cement concrete leachate indicate that PAHs are not leached and measureable levels. Sample metal concentrations did not exceed RCRA metal limits, with the exception of chromium.

Table 1. Summary of Literature Review for Cement Metal Analysis

Metal	Concentration ppb			No. of Studies	Metal	Concentration ppb			No. of Studies
	Min.	Ave.	Max.			Min.	Ave.	Max.	
Aluminum	NA	98	NA	1[A]	Manganese	NA	NA	NA	NA
Antimony	3	13	63	1[B]	Mercury	0.1	0.55	4.97	2[B, C]
Arsenic	5	27	84	3[C,A,B]	Molybdenum	NA	NA	NA	NA
Barium	35000	172000	767000	2[C, B]	Nickel	60	110	170	1[B]
Beryllium	0.1	0.5	3.0	1[B]	Selenium	1	11	25	2[B, C]
Cadminum	0.3	1.9	12.3	1[B]	Silver	0	70	120	2[B, C]
Chromium	70	540	1540	3[C,A,B]	Thallium	2	10	28	1[B]
Cobalt	NA	NA	NA	NA	Vanadium	NA	7	NA	1[A]
Copper	NA	NA	NA	NA	Zinc	NA	NA	NA	NA
Lead	2	9	29	2[B, C]					

[A] (Sadecki et al., 1996) NA=Not applicable

[B] (Portland Cement Association, 1992)

[C] (Kriech, 1992a)

Bituminous Binders

Bituminous binders investigated include hot applied asphalt, emulsified asphalt, cutback asphalt, crumb rubber modified asphalt, as well as rapid cure patch mixes. Kriech (1990) investigated the leachability of hot mix and cold mix asphalts. An AC-20 grade of hot applied asphalt was tested to determine what materials, if any were leached from the hot mix. The AC-20 was provided by Asphalt Materials, Inc. in Indianapolis, Indiana and the aggregate was supplied by Martin Marietta, which contained #11 Levy slag, # 11 stone and #24 sand. The materials were tested for metals, volatiles, semivolatiles, organics and PAHs using EPA SW-846 methods, including the TCLP method. Metals investigated include barium, cadmium, lead, silver, arsenic, selenium, and mercury. Only chromium had a concentration level greater than the detection limit of 0.1 ppm, which is 50 times below the RCRA level for chromium. No volatile or semivolatile organic compounds were observed above the detection limit. The only PAH detected in the study was napthalene, with a concentration of 0.25 μg/L, which is below regulatory guidelines.

In another study by Kreich (1991), asphalt and soils from a roadway were tested to determine the suitability of using these materials as clean fill. Substances studied in this project include PAHs and heavy metals (barium, cadmium, chromium, lead, silver, arsenic, selenium, and mercury). The test specimens were taken from the hot mix asphalt pavement sections of pavement on Route #4 south of Springfield, Illinois, which was built in 1976. Three sampling sections were randomly selected across the pavement. Samples were taken between the wheel paths, in the outer wheel path, outside the outer wheel path, and from the shoulder. Laboratory samples of hot mix asphalt were prepared by the Illinois Department of Transportation (IDOT) to use as controls. The TCLP (SW846-1311) and other EPA approved test methods were used in this study.

The laboratory samples from IDOT contained no measurable PAHs. The hot mix asphalt (HMA) sample contained measurable barium. The HMA sample leached small amounts of naphthalene and phenanthrene, and the only heavy metal detected was barium. However, barium was detected in the laboratory sample and the field sample, suggesting aggregate may be the source of barium. Soil samples from the HMA shoulder contained measurable levels of naphthalene. The study indicated HMA pavements have low leachable metals and PAH material. Also, the study investigated leachate from PCC pavement and observed that leachate from PCC and HMA pavements are similar. The importance of this study is that the long term environmental impacts of using hot mix asphalt as a paving material were investigated and found to be negligible (Kreich, 1992a).

Kreich (1992b) also investigated the leachability of cold mix asphalt (CMA) pavements. The asphalt used in this study was HFMX-2s (asphalt emulsion), MC-30 (cutback asphalt), and CM-150 (Gelled asphalt); all of which are used in the United states for making CMA. The aggregate used in this study was Indiana limestone. Asphalt Materials Inc. in Indianapolis provided the HFMS-2s and CM-150. Laketon Refining in Laketon, Indiana provided the MC-30. Metals, volatile organics, semivolatile organics and polynuclear aromatic hydrocarbons (PAHs), where analyzed in this study. The TCLP (SW846-1311) and other EPA approved methods (SW846-7420, 3510, 8310, and 3010) were used in this study. No metals, semivolatiles, and volatiles from any mixture were observed above detection limits. PAH compounds had very low concentrations.

Many researchers have focused on metal contamination of the roadside environment by indicating sources and pathways of contamination by metal and organic compounds. The stone material in bituminous pavement is frequently neglected when considering ion metal discharge. However, Lindgren (1996) presented the results of a study considering stone material in the asphalt as a source of metal contamination. Stone material may be worn and carried away in stormwater runoff. The transport of pollutants is controlled by the reaction of the metal ions with the solid stone material, thus the absorption characteristics of lead (Pb), copper (Cu), zinc (Zn) and cadmium (Cd) were evaluated. Two rock minerals, gabbro and porphyry, were evaluated because of their high volume use in Swedish asphalt pavements.

A chemical analysis of gabbro and porphyry using inductively coupled plasma atomic emission spectrometry (ICP-AES) and plasma mass spectrometry (ICP-MS) indicated a high content of some metals in these asphalt aggregates, with gabbro having a higher content of most metals than porphyry. Gabbro has a higher capacity of adsorbing metals ions than porphyry. The adsorption capacity, in moles, occurs in this order: Pb=Cu>Zn>Cd. The results of the study indicate that aggregate particles in asphalt concrete may have a high metal adsorption capacity, which may affect traffic generated pollution transport (Lindgren, 1996). Table 2 provides a brief summary of the metal concentrations detected in bituminous binders for the 19 metals analyzed in this survey. Table 3 provides the results of organic compound analysis in leachate. Appendix A contains further information regarding metal analysis studies of bituminous binders.

The results of these studies indicate that low concentrations of PAHs such as naphthalene and phenanthrene were detected in bituminous binder samples, but the PAH concentrations were below regulatory guidelines. Heavy metals including lead, copper, zinc, and cadmium were observed in bituminous binder pavement samples, but the source of these metals is believed to be the aggregate used in the asphalt pavement. Volatile and semi-volatile organic compounds were not detected in any of the samples analyzed in these studies.

Table 2. Summary of Literature Review for Bituminous Binder Metal Analysis

Metal	Concentration ppb			No. of	Metal	Concentration ppb			No. of
	Min.	Ave.	Max.	Studies		Min.	Ave.	Max.	Studies
Aluminum	NA	NA	NA	NA	Manganese	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	Mercury	<5	<5	<5	3 [A,B,C]
Arsenic	<5	<5	<5	3 [A,B,C]	Molybdenum	NA	NA	NA	NA
Barium	<2000	32000	3700	3 [A,B,C]	Nickel	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	Selenium	<10	<10	<10	3 [A,B,C]
Cadminum	<20	<20	<20	3 [A,B,C]	Silver	<40	<40	<40	3 [A,B,C]
Chromium	NA	100	NA	3 [A,B,C]	Thallium	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	Vanadium	NA	NA	NA	NA
Copper	NA	NA	NA	NA	Zinc	NA	NA	NA	NA
Lead	<200	<200	<200	3 [A,B,C]					

[A] (Kriech, 1990)

NA=Not applicable

[B] (Kriech, 1992a)

[C] (Kriech, 1992b)

Table 3. Summary of Literature of Organic Analysis of Bituminous Binder Leachate

Compound	Concentration (ppb)			No. of	Compound	Concentration (ppb)			No. of
	Min	Avg	Max	Studies		Min	Avg	Max	Studies
Acenapthene	NA	0.194	NA	3 [A, B, C]	Hexachlorobenzene	NA	<12	NA	3 [A, B, C]
Acenaphthylene	NA	<0.15	NA	3 [A, B, C]	Hexachlorobutadine	NA	<12	NA	3 [A, B, C]
Anthracene	NA	0.9	NA	3 [A, B, C]	Hexachloroethane	NA	<12	NA	3 [A, B, C]
Benzo(a)anthracene	NA	<0.48	NA	3 [A, B, C]	Indeno-1,2,3-c,d pyrene	NA	<0.021	NA	3 [A, B, C]
Benzo(b)fluoranthene	NA	<0.20	NA	3 [A, B, C]	2-Methylphenol	NA	<30	NA	3 [A, B, C]
Benzo(k)fluoranthene	NA	<0.013	NA	3 [A, B, C]	4-Methylphenol	NA	<30	NA	3 [A, B, C]
Benzo(ghi)perylene	NA	NA	NA	NA	Napthalene	NA	14	NA	3 [A, B, C]
Benzo(a)pyrene	NA	<0.23	NA	3 [A, B, C]	Nitrobenzene	NA	<12	NA	3 [A, B, C]
Chrysene	NA	<0.017	NA	3 [A, B, C]	Phenanthrene	NA	1.1	NA	3 [A, B, C]
Dibenzo(a,h)anthracene	NA	<0.18	NA	3 [A, B, C]	Pyrene	NA	1.3	NA	3 [A, B, C]
1,2-Dichlorobenzene	NA	NA	NA	NA	1,2,4-Trichlorbenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	<12	NA	3 [A, B, C]	2,4,5-Trichlorphenol	NA	<30	NA	3 [A, B, C]
Fluoranthene	NA	0.19	NA	3 [A, B, C]	2,4,6-Trichlorophenol	NA	<30	NA	3 [A, B, C]
Fluorene	NA	3.4	NA	3 [A, B, C]		NA		NA	

[A] (Kriech. 1990) NA=Not Applicable

[B] (Kriech. 1992a)

[C] (Kriech. 1992b)

Conventional Aggregate

In general, investigations of the environmental impacts of conventional aggregate is lacking. Lindgren (1996) investigated gabbro and porphyry aggregate as the source of metal contamination that is leached by asphalt road ways into the environment.

Lime

Information could not be founding regarding the environmental impacts of lime.

Reclaimed Asphalt Pavement (RAP)

RAP has been reused and recycled for many years providing benefits such as conservation of landfill space and reduced cost of new asphalt mixes. The environmental suitability of RAP in transportation projects is currently being addressed, and the prospect of using RAP in construction and maintenance projects is promising. Most studies have focused on reusing RAP in new asphalt pavement, investigating the impacts RAP stockpiles have on the surrounding environment or using RAP as a clean fill.

Runoff from RAP stockpiles, leachate from fill material, and asphalt pavement containing recycled materials have the potential to contaminate surface water, groundwater and soils. A study by the Minnesota Department of Transportation created three experimental stockpiles (RAP, coarse concrete material, and fine concrete material) and analyzed stockpile runoff for pH, conductance, total suspended solids, total volatile solids, sodium, chloride and arsenic. Of all the parameters tested, only chromium and pH exceeded Minnesota surface water quality standards for all stockpiles. Polynuclear aromatic hydrocarbons (PAHs) concentrations were at or below detectable limits for all stockpiles (Sadecki et al., 1996).

Another study addressed the environmental concerns of RAP leachate using three methods to generate leachate from RAP and analyzing the leachate for volatile organic carbons (VOCs), PAHs, and heavy metals. In general, only one of the heavy metals (lead) was detected at concentrations greater than the drinking water standards and all of the VOCs and PAHs were detected below the detection limit and regulatory guidelines (Brantley and Townsend, 1999).

A study in Montana used asphalt samples taken from test sections on 1-90 near Big Timber to analyze the presence and concentration of materials leached from the samples. The TCLP was used to evaluate the "worst case" scenario with regard to material leached from material samples. The leachate samples were analyzed for metals and polynuclear aromatic compounds. None of the metals targeted in this study were observed nor were polynuclear aromatic compounds above detectable levels in any of the samples (Pribanic, 1994).

The environmental suitability of using RAP as a clean fill has also been investigated. Six RAP samples were tested for polychlorinated biphenyls (BCPs), metals, PAHs, and semivolatile organic carbons. Semivolatiles and BCPs were not detected in any of the RAP samples and only trace concentrations of PAHs were detected. Only barium, chromium and lead were detected in the RAP samples, but the concentrations were less than the RCRA guidelines (Kriech, 1991). Table 4 provides a brief summary of studies analyzing RAP for metals and Table 5 provides the results of studies analyzing for organic compounds in RAP samples.

In summary, only pH, chromium, barium and lead have been observed to exceed regulatory standards. PAHs, volatile organic compounds, or semivolatiles organic compounds were at or below detectable concentration in these studies. Appendix A contains a more detailed summary of metal concentrations and organic concentrations detected in RAP.

Table 4. Summary of Literature Review for RAP Metal Analysis

Metal	Concentration ppb			No. of Studies	Metal	Concentration ppb			No. of Studies
	Min.	Ave.	Max.			Min.	Ave.	Max.	
Aluminum	NA	NA	NA	NA	Manganese	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	Mercury	<5	<5	<5	2 [A,B]
Arsenic	<5	<5	<5	2 [A, B]	Molybdenum	NA	NA	NA	NA
Barium	3300	3600	4000	3 [A, B, C]	Nickel	<100	<100	<100	1 [C]
Beryllium	NA	NA	NA	NA	Selenium	<25	<25	<25	2 [A,B]
Cadminum	<5	<5	<5	3 [A, B,C]	Silver	<40	<40	<40	2 [A,B,]
Chromium	<50	NA	520	3 [A,B,C]	Thallium	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	Vanadium	NA	NA	NA	NA
Copper	<500	<500	<500	1 [C]	Zinc	<500	<500	<500	1 [C]
Lead	<200	NA	1800	3 [A,B,C]					

[A] (Pribanic, 1994) NA=Not Applicable

[B] (Kriech, 1991)

[C] (Brantley, 1998)

Table 5. Summary of Literature of Organic Analysis of RAP Leachate

Compound	Concentration (ppb)			No. of Studies	Compound	Concentration (ppb)			No. of Studies
	Min	Avg	Max			Min	Avg	Max	
Acenapthene	NA	<0.2	NA	3 [A, B, C]	Hexachlorobenzene	NA	<50	NA	1 [B]
Acenaphthylene	<0.20	NA	0.49	3 [A, B, C]	Hexachlorobutadine	NA	<50	NA	1 [B]
Anthracene	NA	<0.017	NA	3 [A, B, C]	Hexachloroethane	NA	<50	NA	1 [B]
Benzo(a)anthracene	<0.013	NA	0.017	3 [A, B, C]	Indeno-1,2,3-c,d pyrene	NA	<0.02	NA	3 [A, B, C]
Benzo(b)fluoranthene	NA	<0.01	NA	3 [A, B, C]	2-Methylphenol	NA	<50	NA	1 [B]
Benzo(k)fluoranthene	<0.017	NA	0.05	3 [A, B, C]	4-Methylphenol	NA	<250	NA	1 [B]
Benzo(ghi)perylene	NA	<5.0	NA	1 [C]	Napthalene	<0.13	0.4	0.49	3 [A, B, C]
Benzo(a)pyrene	NA	<0.020	NA	3 [A, B, C]	Nitrobenzene	NA	<250	NA	1 [B]
Chrysene	NA	<0.033	NA	3 [A, B, C]	Phenanthrene	<0.13	0.4	0.49	3 [A, B, C]
Dibenzo(a,h)anthracene	NA	<0.02	NA	3 [A, B, C]	Pyrene	NA	<0.60	NA	3 [A, B, C]
1,2-Dichlorobenzene	NA	<1.0	NA	1 [C]	1,2,4-Trichlorbenzene	NA	<1.0	NA	1 [C]
1,4-Dichlorobenzene	NA	<1.0	NA	2 [B, C]	2,4,5-Trichlorphenol	NA	<250	NA	1 [B]
Fluoranthene	NA	<0.068	NA	3 [A, B, C]	2,4,6-Trichlorophenol	NA	<50	NA	1 [B]
Fluorene	NA	<0.015	NA	3 [A, B, C]					

[A] (Pribanic. 1994)

[B] (Kriech. 1991)

[C] (Brantley. 1998)

NA=Not Applicable

Recycled Concrete Pavement (RCP)

Another material frequently used as a construction material in transportation construction projects is crushed concrete. As with RAP, concern has arisen regarding the environmental impacts of reusing crushed concrete. Most studies have focused on impacts of using crushed concrete as base courses or the implications of runoff from crushed concrete stockpiles.

Sadecki et al. (1996) analyzed runoff from coarse concrete stockpiles. Of the metals analyzed in the stockpile runoff, only chromium was detected in concentrations exceeding the Minnesota surface water quality standards. Other metals detected in the runoff with concentrations less than the Minnesota surface water quality standards were arsenic, barium, lead, mercury, selenium, and silver.

The most significant environmental concern of using crushed concrete in base courses is the alkalinity level of base course leachate. The leachate is extremely alkaline; however, the base course effluent is usually diluted in a short distance by surface runoff. Environmental concern is highest for soils near the road bed (Snyder, 1995).

A stockpile study in Minnesota collected runoff from a coarse concrete material stockpile and a fine concrete material stockpile. Of all the parameters tested, only chromium and pH exceeded Minnesota surface water quality standards. Polynuclear aromatic hydrocarbons (PAHs) concentrations were at or below detectable limits for all stockpiles. Chloride concentrations from the concrete stockpiles exhibited a decreasing trend with each storm event (Sadecki et al., 1996). Tests indicate that RCP samples did not exceed RCRA metal limits and chromium was the only metal detected that exceeded Minnesota surface water quality standards.

Fly Ash and Bottom Ash

Coal fly ash has been used in construction operations, including as a cement replacement in concrete or a pavement base course material. The materials that leach from fly ash are important because fly ash contains heavy metals such as arsenic, chromium, nickel, copper, cadmium and manganese; many of these heavy metals are toxic to humans or plants. Transportation departments are using fly ash from coal-fired generators in many of their transportation projects. Fly ash may be used as a embankment fill material, a component of concrete, or as a roadbase stabilization material.

The major group evaluating the environmental suitability of fly ash in transportation projects are utility companies. The Electric Power Research Institute has initiated many projects investigating the environmental suitability of fly ash. For example, coal combustion by-products were used to construct a highway embankment to demonstrate the feasibility of using fly ash in highway construction (GAI Consultants, 1989). A seven-lane section of Interstate 279 in Pittsburgh was chosen as the demonstration site. The fly ash embankment was capped with a 5-foot thick soil cover to minimize surface water infiltration and to control erosion of the fly ash. A one-foot thick underdrain was placed at the base of the fill to prevent saturation. Fly ash from the Cheswick Power Station was used to construct the embankment.

A leachate analysis was performed on the Cheswick fly ash and additional leachate tests were performed during the project to determine whether leachate quality was constant throughout the project. Leachate analyses were performed using the EP Toxicity Procedure (EP) (SW846, Method 1310) and ASTM D3987. Eighteen metals and 12 other constituents were monitored in this study. The results of the leachate tests were compared to the EPA drinking water standards and hazardous waste criteria; the fly ash was considered non-toxic and non-hazardous (GAI Consultants, 1989).

In another project, the Delmarva Power and Light Company (1989) evaluated the environmental effects of using fly ash as an embankment material under a Delaware interstate highway ramp. The Delmarva Power and Light Company's Edge Moor Station in Wilmington and the Atlantic Electric Company's Deepwater Station in Penn's Grove, New Jersey provided fly ash for the project. Five ash sources were tested: Delmarva stockpiled fly ash, Delmarva fresh fly ash, New Jersey Stockpile fly ash, New Jersey fresh fly ash, and Delmarva bottom ash. The EP toxicity test and ASTM D3987, Method A, leachate tests were performed on the fly ash samples. Eight metals were tested including arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

The background tests of the fly ash before construction for the two leachate tests indicate the ash samples are non-toxic and non-hazardous because the metal concentrations were below the RCRA toxicity limits. However, in comparing the results of each test, the tests resulted in different metal concentrations. Prior to the construction of the ramp, four groundwater monitoring wells were installed in the vicinity of the highway ramps. The groundwater samples were tested for 20 substances including the metals previously listed. There were no exceedences of drinking water standards in samples from the upgradient monitoring wells (No. 1 and 4). Of the 8 toxic inorganic metals, four (arsenic, cadmium, mercury, and silver) were not detected in any of the samples from wells number 1 and 4. Thirteen incidences of exceeding drinking water standards occurred in well number 2 including 9 for total dissolved solids (TDS), 3 for iron (Fe), and one for sulfates (SO_4). Of the 8 toxic metals, three (cadmium, mercury, and silver) were below detection limits and there were no occurrences of exceeding drinking water standards for the metals. In well number 3, there were only 4 exceedences of drinking water standards, which were all for selenium. Of the 8 toxic inorganic metals, only two (mercury and silver) were below detection limit in well number 3; however, there were no exceedences of drinking water standards. The concentration of the constituents measured over two years remained relatively the same (Delmarva Power and Light, 1989).

Type C coal ash was used in three Kansas roadbase stabilization projects (Kansas Electric Utilities Research Project, 1989) to demonstrate full-scale application of ash use in highway base course construction and to monitor the impact the fly ash may have on groundwater. Three test sections were used in the study; they were in Lenexa, Topeka, and Wichita. Class C fly ash from the Jeffrey Energy Center was chosen for the Topeka and Wichita projects while fly ash from the LaCygne generating facility was used in the Lenexa project. To test potential leaching of heavy metals, the subgrade soil was analyzed for specific elements prior to and following construction of the stabilized section. The soil samples were taken from discrete locations that could be duplicated after construction. Sampling of the subgrade was accomplished using a 3-inch shelby tube sampler advanced in 2 inch intervals. Fly ash samples were also taken during sampling.

A total metal analysis was conducted on each of the three subgrade samples and the fly ash. Of the 23 metals identified, only 8 had higher observed concentrations in the Jeffrey fly ash than the subgrade soil. Those metals are antimony, barium, beryllium, cadmium, chromium, molybdenum, nickel, vanadium and zinc. The pH of the fly ash was greater than the pH of the subgrade soils. The EP Toxicity tests was conducted on the fly ash sample to further evaluate the leaching potential of the fly ash and the metals with higher concentrations in the fly ash were evaluated. Of the eight metals, five (antimony, beryllium, chromium, vanadium, and zinc) were not detected in the EP toxicity test. Only barium, cadmium, and chromium were detected; however, the metal concentrations were significantly lower than the maximum contaminant level (MCL) (Kansas Electric Utilities Research Program, 1989).

Church et al. (1995) investigated the identity of toxicity elements released when leachate was generated from Alaskan coal fly ash. The EPA's Toxicity Characteristic Leaching Procedure (TCLP) test was used to identify toxicity hazards. Six groups of triplicate specimens were used to investigate the leaching of fly ash under the following conditions: compaction, curing, freeze-thaw, and cement stabilization. The leachate was analyzed by Inductively Coupled Plasma Atomic Emission Spectrophotometry (ICP-AES) for 15 elements (Al, Ba, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Si, Sr, Ti, and V). Mercury in the leachate was analyzed using cold vapor atomic absorption spectrophotometry.

Results showed that high levels of barium were released from the ash when leached with distilled water; however, TCLP test did not identify the barium release as a potential hazard. Dissolved metal concentrations were typically below 10 percent of the maximum allowable levels. The concentrations of six elements (Cr, Co, Cu, Fe, Mn and V) in the leachate were near or below detection limits. Maximum concentration of mercury in any of the 26 leachate samples was 2 $\mu g/L$. The leaching trends for the nine chemical species tested are as follows. The leachate concentrations of calcium, barium and strontium increased initially but decreased with time.

Sodium and potassium concentrations in the leachate initially decreased, followed by gradual and sharp concentration increases. Silicon and aluminum leachate concentrations gradually increased until the end of the study when they increased sharply. The leachate concentrations of magnesium and titanium did not have a leaching trend. The authors felt that the TCLP test may not accurately predict worst-case field leaching because barium leaching occurred to a greater extent in the column study using distilled water.

Garcez (1984) investigated the influence of stabilization on leachate quantity and quality of lignite and subbituminous fly ash. Two stabilized mixtures were used in the study, one mixture was 30 percent subbituminous fly ash in soil and the other mixture was 100 percent subbituminous fly ash. The results of the study indicate that little change in leachate quality occurred by stabilizing the samples. The soil stabilization process was not effective in reducing the leachability of elements due to the low cation exchange capacity of the soil. Arsenic, cadmium, iron, lead and manganese concentrations exceeded US EPA standards.

Leachate tests of fly ash samples from a Texas power plant were performed to develop a methodology for predicting long-term leaching potential of heavy metals in fly ash. The column leaching test was used to determine the release of contaminants from coal combustion residues because the test results correlate well with the results from field tests. Mostofa (1995) used a model developed by Belevi and Baccini that predicts the leaching behavior of heavy metals from a MSW landfill to estimate the leaching behavior of heavy metals from fly ash generated at a coal power plant. The metals observed in this experiment include arsenic, boron, calcium, chromium, copper, selenium, potassium, and sodium. All of the metals but arsenic, calcium, and copper concentrations exponentially decreased. Calcium experienced an increase in concentration before following the exponential decrease. Arsenic and copper did not follow a leaching trend. The metals studied in this experiment followed the model developed by Belevi and Baccini (Mostofa, 1995).

Tests were conducted to examine the environmental characteristics of atmospheric fluidized bed combustion (AFBC) ash, stoker ash, and fly ash. The AFBC ash samples are composed of four categories: baghouse ash, heat recovery ash, spent bed, and stoker ash. Combustion by-products were obtained from two sources, and both sources use high-sulfur Indiana coal. Chemical analyses indicated the AFBC baghouse and heat recovery ash are composed primarily of silicon, aluminum, iron, and sulfur; the spent bed ash is primarily composed of calcium, iron, and aluminum. The fly and stoker ashes are primarily composed of silicon, iron and aluminum. The TCLP was conducted on the fly and stoker ashes and the EP Toxicity test was conducted on the baghouse, heat recovery, and spent bed ash. The EP Toxicity test is similar to the TCLP test except acids are periodically added to maintain pH levels. The Indiana Neutral Water Leachate Test (NWLT) was performed for ash samples. The NWLT is conducted similarly to the EP Toxicity test without the addition of acid. The Indiana NWLT tests indicate the AFBC ash contains high levels of sulfate, total sulfide, dissolved solids and pH. The chemical analysis and the leachate tests indicate the AFBC ash does not exceed EPA Hazardous Waste Standards for inorganic materials, but the impact of increased levels of sulfide on groundwater quality needs to be investigated (Deschamps, 1997).

Bottom ash has also been investigated to determine the environmental impacts of this material used in transportation construction and maintenance projects. An environmental evaluation of

Indiana bottom ash indicated that the bottom ash was nonhazardous, had minimal effect on groundwater quality, low radioactivity, and low erosion potential. However, the ash is potentially corrosive. Bottom ash leachates produced by the extraction procedure (EP) toxicity tests were analyzed to predict the potentially hazardous nature of heavy metals. To determine the effects on groundwater quality, the salt content of bottom ash leachates were evaluated using the leachate test method specified in the Indiana Administrative Code 329 (IAC 2-9-3). The test is conducted as specified for the EP toxicity test, but acetic acid is not used. The results of the IAC2-9-3 leachate test were compared to the maximum contaminant level (MCL) specified for restricted waste sites and the Secondary Drinking Water Standards. The corrosiveness of the bottom ash was evaluated using minimum resistivity, pH, soluble chloride, and soluble sulfate. The materials with lower minimum resistivity and pH and with higher contents of soluble chloride and soluble sulfate are more corrosive. The California Tests 417 and 422 were used to determine the sulfate content and chloride content, respectively. Erosion potential was estimated using the Universal Soil Loss Equation by predicting the soil erodibility factor (K). The radioactivity of bottom ash was evaluated by the activity of Radium-226 (Lovell et al., 1991).

Most of the studies indicate that metals concentrations in fly ash leachate do not exceed RCRA metal limits; however, one study identified arsenic, cadmium, iron, lead, and manganese concentrations in fly ash leachate exceeding RCRA standards. Many studies identified metal concentrations in fly ash leachate greater than drinking water standards, but less than RCRA standards.

The summary of the literature review results for fly ash and bottom ash are provided in Table 6 and Table 7. Table 6 summarizes metal concentrations for laboratory leaching procedures performed on fly ash and bottom ash. Table 7 summarizes long-term leaching and runoff studies of highway ramps and embankments filled with fly ash for the 19 metals analyzed in this study. For more detailed information, please refer to Appendix A.

Table 6. Summary of Leachate Test from the Literature Review for Coal Fly Ash Metal Analysis

Metal	Concentration ppb			No. of Studies	Metal	Concentration ppb			No. of Studies
	Min.	Ave.	Max.			Min.	Ave.	Max.	
Aluminum	NA	24500	NA	2 [C, D]	Manganese	NA	270	NA	3 [A, C, D]
Antimony	NA	<100	NA	2 [C, D]	Mercury	<0.4	<0.4	<0.4	4 [A, C, D, E]
Arsenic	<5	<5	<5	5 [A, B,C,D, E]	Molybdenum	NA	130	NA	2 [C, D]
Barium	NA	2180	NA	4 [A, B, C, D, E]	Nickel	NA	110	NA	3 [A, C, D]
Beryllium	NA	NA	NA	NA	Selenium	23	481	2680	6 [A, B, C, D, E, F]
Cadminum	<5	<5	<5	3 [A, B,C]	Silver	NA	520	NA	5 [A, B,C,D, E]
Chromium	16.5	550	1379	6 [A, B, C, D, E, F]	Thallium	NA	<500	NA	1 [D]
Cobalt	NA	NA	NA	NA	Vanadium	NA	<500	NA	1 [D]
Copper	<20	<20	<20	3 [A, C, D]	Zinc	NA	130	NA	3 [A, C, D]
Lead	100	100	100	5 [A, B,C,D, E]					

[A] (Deschamps, 1997) [D] (Kansas Electric Untilities Reserarch Program, 1989) NA=Not Applicable

[B] (Kuchibhotla, 1996) [E] (Delmarva Power and Light, 1989)

[C] (GAI Consultants, 1989) [F] (Mostofa, 1995)

Table 7. Summary of Groundwater and Runoff Analyses from the Literature Review for Coal Fly Ash Metal Analysis

Metal	Concentration ppb			No. of	Metal	Concentration ppb			No. of
	Min.	Ave.	Max.	Studies		Min.	Ave.	Max.	Studies
Aluminum	101	186	356	1[A]	Manganese	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	Mercury	<5	<5	<5	1[A]
Arsenic	<2	4	6	1[A]	Molybdenum	NA	NA	NA	NA
Barium	68	103	163	1[A]	Nickel	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	Selenium	7	12	14	1[A]
Cadminum	<1.0	<1.0	1	1[A]	Silver	<1	<1	<1	1[A]
Chromium	<1	1	2	1[A]	Thallium	NA	NA	NA	Na
Cobalt	NA	NA	NA	NA	Vanadium	NA	NA	NA	Na
Copper	3	11	29	1[A]	Zinc	99	118	154	1[A]
Lead	<1	1	3	1[A]					

[A] (Delmarva Power and Light Company, 1989) NA=Not Applicable

Summary of State Requirements

Another component of this task was the investigation of other states' regulations regarding the use of traditional construction materials such as cement, conventional aggregate and fly ash. Information was obtained by contacting the states and requesting regulations regarding the materials investigated in this study. Eight states provided written information regarding their environmental policy for the use of traditional or recycled materials used in DOT applications. These states do not have regulations addressing environmental impacts of conventional aggregate, bituminous binders or Portland cement. However, many states have regulated the use of fly ash in DOT operations. State contacts were taken from a report done by the New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials, who investigated the use of recycled material in DOT projects (NYSDEC 1996). The information asked during phone conversations with a state agency representative was 1) do you work for the State DOT or environmental agency; 2) how were the specifications developed for traditional and/or recycled materials; 3) could you provide a copy of specifications; 4) do you have lab data we could review; and 5) do you have any field data we could review? The states having formal requirements are discussed below.

<u>California</u>

In California, the reuse of waste materials in roadway application is governed by two sets of specifications. Many local jurisdictions use the California Department of Transportation's (Caltrans) Specifications. Existing Caltrans specifications covers aggregate bases and subbase in Sections 25 and 26. Reclaimed asphalt concrete, Portland cement concrete, lean concrete base, and cement treated base is allowed in Class 2 and 3 aggregate base and in Class 1, 2, 3, and 4 aggregate subbases (Caltrans, 1999).

The other source of specifications in California is the *Greenbook*, which is commonly used in Southern California. The *Greenbook*, also referred to as *Standard Specifications for Public Works Construction*, is used by the city and county of Los Angeles and 200 other local governments and agencies in the Los Angeles area. A hierarchy exists for the use of untreated base materials. The order of preference for base materials is crushed aggregate base or crushed slag base, crushed miscellaneous base, processed miscellaneous base and select subbase. Crushed aggregate base should only include crushed rock and rock dust. Only crushed slag from blast furnace or steel furnace operations can be used. Crushed miscellaneous base may include broken and crushed asphalt concrete or Portland cement concrete. Processed miscellaneous base may consist of broken or crushed asphalt concrete, Portland cement concrete, glass, or natural material. Select subbase contains specifications for subbases consisting of soil mineral aggregates, asphalt concrete, Portland cement concrete, slag, or blends of these materials. All materials used as a base must meet the grading requirements and quality requirements specified in the corresponding base category (e.g. processed miscellaneous base or crushed aggregate base) (*Greenbook* 1997).

Fly ash may be used in concrete when approved by the engineer, but fly ash should not be used with Type IP or Type III Portland cement. The fly ash shall conform to ASTM C 618 and Greenbook specifications. Recycled asphalt concrete–hot mixed may be used if the material meets class and grading requirements specified in Section 203-7 of the *Greenbook* (*Greenbook*,1997).

Delaware

The reuse of waste products in roadway applications is decided on a case-by-case basis. A written request for approval to use the material is submitted to the governing environmental agency. Approval is granted based on the results of the TCLP test, resulting in a blanket approval for the material throughout the entire state (Personal communication, 1999).

Illinois

The state of Illinois allows coal combustion by-products (CCB) to be used for beneficial purposes. CCB may be used as a raw ingredient or mineral filler in the manufacture of cement, concrete, concrete mortars, and concrete products. Bottom ash may be used as an anti-skid material. CCB may be used as a substitute for lime in the lime modification of soils if the CCB meets Illinois Department of Transportation specifications. In order to use CCB, CCB should not exceed Class I Groundwater standards for metals (when tested utilizing test method ASTM D3987-85) and should not have been mixed with a hazardous waste prior to use. Fly ash should be applied in a manner that minimizes the generation of airborne particles and dust. Unless otherwise exempted, the users of CCB should provide notification to the Illinois Environmental Protection Agency for each project using CCB. The documentation should include information about the quantity of CCB utilized and certification that the CCB has not been mixed with a hazardous material and will not exceed Class I Groundwater standards. Notification is not required for pavement base, parking lot base, or building base projects using less than 10,000 tons of CCB and other projects utilizing less than 100 tons of CCB (Personal Communication, 1999).

Kentucky

Coal combustion by-products may be used as an ingredient or substitute ingredient in the manufacture of products such as cement, concrete, paint, plastics, anti-skid material, highway base course, and structural fill. However, the material must meet the following conditions. (1)

The utilization of coal combustion by products must not create a nuisance condition. (2) Erosion and sediment control measures are consistent with sound engineering practices. (3) The use of coal by-products is not within 100 feet of existing streams, 300 feet of drinking water supply wells, floodplains, or wetlands unless granted permission by the regulatory agency. (4) The producer must declare the coal combustion by-products nonhazardous. (5) The generator of the waste must supply a report to the cabinet that identifies the type and amount of waste released for reuse, the name and address of the recipient of the waste, the specific use of the waste (if known). More information about Kentucky's coal combustion by-products beneficial use program is available at 401 KAR 45:060 concerning special waste permit-by-rule (KAR, 1999).

New York

The state of New York has a beneficial use determination (BUD) program (NYCCRR, 1998), which focuses on the reuse of solid waste that is not regulated as a sewage sludge. Materials that cease to be solid waste in the BUD program include compost, wood chips, glass, construction and demolition waste (brick, asphalt pavement, uncontaminated concrete and concrete products). Coal combustion bottom ash may be used as a component of asphalt or traction agents on roadways, parking lots and driving surfaces. Coal combustion fly ash or gas scrubbing products may be used as an ingredient of lightweight aggregate. Coal combustion fly ash or coal combustion bottom ash may serve as a cement or aggregate substitute in concrete or concrete products or as a raw feed in cement.

Beneficial use determinations may be made on a case-by-case basis. The generator or proposed user of the solid waste must petition the New York State Department of Environmental Conservation (NYSDEC), Division of Solid and Hazardous Materials in writing. The petition must include a description of the solid waste as well as the chemical and physical properties of the waste. The petitioner must show one of the following: (1) contract to purchase; (2) a description of how product will be used; (3) demonstrate that the product complies with industry standards and specifications; (4) document that markets or uses exist. The product should not adversely affect human health and safety, the environment, or natural resources. The petition should also include a solid waste control plan. More information regarding the New York's BUD program is available in Title 6, Part 360 of the New York Department of Environmental Conservation Official Compilation of Code, Rules, and Regulations (NYCCRR, 1998).

Pennsylvania

Title 25, Chapter 287, Subchapter H of the Pennsylvania Code regulates the beneficial use of residual waste, including coal ash. The Pennsylvania Department of Environmental Protection may issue a general permit for a specific category of beneficial use or processing of residual waste on a regional or statewide basis. In that case, persons or municipalities who intend to beneficially use or process the waste must do so in accordance with the terms and conditions of the general permit and do not have to file an individual application. Municipalities, companies or persons may apply for the issuance of a general permit. To obtain a general permit, the application must contain the following: (1) a description of the waste to be used and the proposed type of beneficial use or processing; (2) a narrative and schematic of the production/manufacturing process; (3) the concentration limits for contaminant in the waste which is to be beneficially used; and (4) the ability of the waste to meet virgin material standards if the material is being used in lieu of virgin material. If the material is to be used as a construction material, soil substitute, soil additive, anti-skid material, or placed directly onto the land, the potential for adverse public health and environmental impacts must be evaluated. For more information about the Pennsylvania beneficial use of materials, see the Pennsylvania Code (Pennsylvania Code, 1998).

West Virginia

In West Virginia, reuse of waste products in roadway construction is determined on a case-by-case basis by the environmental agency. The West Virginia Department of Transportation or the material producer must provide a written request of approval to use the material. Once the material is approved, it receives blanket approval for the entire state (Personal Communication 1999).

Wisconsin

The Wisconsin Department of Natural Resources can provide exemptions from Solid Waste Management Requirements specified in NR 500 to 539. A person may apply for exemptions with a written request along with the appropriate documentation that demonstrates the waste will not cause environmental pollution. The department may grant exemptions from the requirements of Chapter 289 to encourage the recycling of solid waste. Any exemptions from Chapter 289 will be provided in writing (Wisconsin Administrative Code Register, 1998).

TxDOT District Material Use Survey

TxDOT districts were contacted to determine the type of materials used in construction and maintenance projects. The information gained in the survey was used to determine which materials were most abundantly used and potential suppliers of these materials. Information obtained during the survey includes: the name of the district; the contact's name, title and division; the type of aggregate used (limestone, caliche, gravel, and sandstone); and if the district uses RAP and RCP. Additionally, the districts were asked if they used a pre-made rapid cure patch mix. Districts using RAP and RCP were asked if they had stockpiles of these materials and if we could obtain samples from these stockpiles. All 25 of the districts were contacted; however, only 18 districts participated in the survey.

From the survey, the most abundantly used aggregates as a granular base material are limestone, gravel, caliche and sandstone. For use as aggregate in hot-mix applications or Portland cement concrete, the aggregates most frequently used are limestone, gravel, sandstone and caliche. Fourteen of the 18 districts use RAP, while only 7 districts reported using RCP in projects. The percentage that RAP is used in projects varies from 10 percent to 100 percent, depending on the RAP production and the availability of natural aggregate. RAP is used most frequently as a subbase or as an aggregate in hot mix. The districts that use RCP most frequently are Beaumont, Dallas and Houston. The districts participating the survey did not have stockpiles of RCP. Instead, the contractors maintained the RCP stockpiles. In addition, 13 of the 18 districts participating in this survey use rapid-cure patch mixes in their flexible pavement repair operations.

SAMPLING PLAN

Purpose

The purpose of the sampling plan is to ensure that the materials investigated in this project were tested using a scientifically valid plan. In addition, the sampling plan ensures that variations in a sample due to source or geographic location were considered in sampling. Test methods identified in other studies were used in this study so that test results may be compared to previous research studies. The parameters and constituents investigated in this project are provided for each traditional construction and maintenance material. The sampling plan presents a feasible, comprehensive, and scientifically valid plan to test traditional materials to improve the understanding of the environmental impacts of these materials. Tables 8 and 9 provide a list of metals and semi-volatile organic compounds that were analyzed in this project.

Table 8. Metals

Aluminum	Cobalt	Nickel
Antimony	Copper	Selenium
Arsenic	Lead	Silver
Barium	Manganese	Thallium
Beryllium	Mercury	Vanadium
Cadminum	Molybdenum	Zinc
Chromium		

Table 9. Semi-Volatile Organic Compounds

N-Nitrosodimethylamine	4-Chloro-3-methylphenol	4-Bromophenolphenyl ether
Phenol	2-Methylnapthalene	Hexachlorobenzene
Bis(2-chloroethyl)ether	Hexachlorocyclopentadiene	Pentachlorophenol
2-Chlorophenol	2,4,6-Trichlorophenol	Phenanthrene
1,3 Dichlorobenzene	2,4,5-Trichlorophenol	Anthracene
1,4 Dichlorobenzene	2-Chloronapthalene	Carbazole
1,2 Dichlorobenzene	2-Nitroaniline	Di-n-butyl phthalate
2-Methylphenol	Dimethyl phthalate	Fluoranthene
Bis(2-chloroisopropyl)ether	2,6-Dinitrotoluene	Pyrene
4-Methylphenol	Acenapthylene	Butylbenzene phthalate
N-Nitrosodi-n-propylamine	3-Nitroaniline	Benzo(a)anthracene
Hexachlorethane	Acenapthene	Chyrsene
Isophorone	2,4-Dinitrophenol	Bis(2-ethylhexyl)phthalate
Nitrobenzene	4-Nitrophenol	Di-n-octyl phthalate
2-Nitrophenol	Dibenzofuran	Benzo(b)fluoranthene
2,4-Dichlorophenol	2,4-Dinitrotoluene	Benzo(k)fluoranthene
Bis(2-chloroethoxy)methane	Diethyl phthalate	Benzo(a)pyrene
2,4 Dimethylphenol	Fluorene	Indoeno(1,2,3-cd)pyrene
1,2,4-Trichlorobenzene	4-Chlorophenylphenyl ether	Debenzo(a,h)anthracene
Naphthalene	4-Nitroaniline	Benzo(ghi)perylene
4-Chloroaniline	2-Methyl-4,6-dinitrophenol	
Hexachlorobutadiene	Azobenzene	

Transport
Samples for this project have been sampled by the company providing the materials or TxDOT employees. Samples were shipped to Texas Tech University using UPS, FedEx, or Central Freight.

QA/QC

Catalog and Storage
All samples were stored in the basement of the structures lab in the Civil Engineering building. The room once served as the curing room for cement samples. The room is in an isolated section of the building with minimal traffic into the area. The room contains shelves, where the samples were stacked so as to not reduce mobility within in the room. The samples for this project were the only samples stored the room. Sample storage containers having lids were closed and aggregate bag samples were tied closed.

When a sample was delivered, the sample was moved to the storage room and cataloged. The information obtained for each sample included the date received, numerical code for identification purposes, a description of the item, how it was shipped, the size, the quantity, and the receiver's initials. Sample information was logged into a notebook to account for each sample. QA samples were performed as specified by the test methods used in this project. The results from QA samples were recorded with the sample data. For the SPLP, blanks and duplicate samples are required to be performed for every 20 runs undergoing the procedure.

Custody forms were used to track the sample migration through lab tests. Each material received by Texas Tech University was tested in triplicate, resulting in three lab samples. Each sample was identified with an Environmental Science Laboratory (ESL) code number. The custody form documented the type of sample and the analysis required.

All equipment was calibrated before use using a minimum of three standards. Checks and blanks were run every 20 samples to ensure the machine was calibrated. If the check concentration was not within 20 percent of it's concentration, the machine was recalibrated and samples were analyzed again. Upon completion of analysis, a bland and check was analyzed again to ensure the machine was still calibrated. When metal analysis was to begin on a new metal, the machine was recalibrated and other procedures were followed as above.

All equipment used in the metal analysis was acid washed using nitric acid, as specified in the SPLP procedure. Distilled, deionized water was used in the experiment, when ever water was necessary.

Time Constraints

Materials were sampled as quickly as possible. Some samples were refrigerated unless refrigeration resulted in irreversibly physical changes to the waste. For metallic analyte extractions, extracts must be acidified to $pH<2$. Holding times are provided in the SPLP method.

Materials to be Tested

Material Types

The traditional materials investigated in this project include Portland cement, bituminous binders, reclaimed asphalt pavement (RAP), recycled concrete pavement (RCP), fly ash, bottom ash, lime and waste tires as crumb rubber modified asphalt. The potential uses of the traditional materials have been reviewed; the potential applications of the materials determine the possible routes of environmental and human exposure. Thus, the most common applications of the materials will be considered when determining the material phase to be tested and the laboratory setup used to investigate potential environmental impacts. Each material type is addressed below including the type of material tested. For almost all the materials, four sources were tested and the providers were chosen from different areas around the state so that different geographic areas around the state were represented.

Portland Cement

The criteria to determine cement suppliers was cement type; cement types evaluated in this project include Type I, II, and I/II. The TxDOT Material/Producer list was used to determine the cement sources evaluated in this project, and further supplier reduction was accomplished using geographic location and the type of cement produced. TxDOT provided approximately 5 gallons for each cement sample analyzed and the sampling was performed by individuals employed by TxDOT or the cement manufacturers.

Bituminous Binders

Bituminous binders is a generic term covering a large group of materials including hot applied asphalt, emulsified asphalt, crumb rubber modified asphalt and cutback asphalt. The bituminous binder types tested in this project, included the three primary binders indicated above, and a binder used in rapid cure patch mixes. The categories of hot applied asphalt evaluated in this project include AC-3, AC-5, PG 64-22, PG 70-22, PG 76-22, MG 10-30 and MG 20-40. TxDOT provided approximately 5 gallons for each bituminous sample analyzed and the sampling was performed by individuals employed by TxDOT or the refinery providing the sample.

Conventional Aggregate

The conventional aggregate evaluated in this project has been divided into six categories: limestone, siliceous gravel, sand (siliceous and waste foundry), sandstone, caliche, and limestone rock asphalt. Company and pit selection was accomplished using the TxDOT Material/Producer List as well as geographic location. Another criteria used to determine the conventional aggregate source was volume of use. In the TxDOT district survey performed by TTU, the districts were questioned about the type of aggregate they used in Portland cement and bituminous applications as well as the suppliers and pits most frequently used. All of this information was used to determine the type and the aggregate sources to be used in this study. Due to the controversial classification, waste foundry sand was analyzed in this study and the results of the analyses are presented in Appendix B. The waste foundry sand results were not included in developing recommendations from this project. TxDOT supplied all conventional aggregate samples and the Harold Albers assisted in choosing the materials analyzed.

Lime

Lime is used in many road construction and maintenance applications. For example, lime is used as a road base or subbase stabilizing material. Due to a variety of potential applications, tests were conducted to determine the environmental impacts of using lime. The types of limes investigated in this study include Type A (hydrated), Type B (slurry), and Type C (quicklime). The TxDOT Material/Producer List and geographic location were the criteria used to determine the sources of lime investigated in this project. TxDOT provided approximately 5 gallons of sample for all of the materials analyzed.

Reclaimed Asphalt Pavement and Recycled Concrete Pavement

Samples were obtained from districts using significant quantities of RAP and RCP. Two criteria, the geographic location and the volume of use, were used to select which districts or construction companies would provide samples for this project. RAP was obtained from three districts, and two districts provided RCP samples. TxDOT provided all of the RAP and RCP samples that were analyzed in this project, and the sampling was performed by TxDOT personnel.

Fly Ash

To accurately evaluate the environmental impacts of fly ash, type A and type B fly ash were investigated. Type A is commonly referred to as Class C and Type B is referred to as Class F; these designations will be used throughout the remainder of this report. Further analysis considering coal source, power plant type, and plant location (information obtained from phone interviews with employees at each company) was used to generate the list of fly ash suppliers. Four Class F fly ash sources and four Class C fly ash sources were analyzed in this project.

Bottom Ash
Selecting bottom ash suppliers was more complicated than selecting fly ash suppliers. For each plant producing fly ash, the plant also produces a bottom ash, and unlike fly ash, bottom ash is not categorized into types. Two criteria, coal source and coal type, was used to reduce the number of bottom ash suppliers; however, due to the difficulty in obtaining bottom ash samples, only one bottom ash source was evaluated in this project.

Sampling Matrix
A sampling matrix defines the material combinations that can be tested in a project. Due to a large number of materials and endless material combinations, the sampling matrix was developed using an "average-case scenario" method. For instance, limestone from different suppliers was tested individually, but the limestone producing a leachate with an average metal concentration was used in a matrix with cement to make concrete. Thus, materials will be tested singularly as well as in a matrix. The matrices considered in this project include Portland cement concrete (cement, fine aggregate, and coarse aggregate), Portland cement concrete with fly ash (cement, fine aggregate, coarse aggregate, and fly ash), and Portland cement concrete with RCP (cement, fine aggregate, coarse aggregate, and RCP). In lieu of making hot-mix asphalt, RAP samples were analyzed for metals and semi-volatile organic compounds.

Sample Preparation
Before the samples were sent to the lab for analysis, sample preparation was necessary for some of the samples. Sample preparation was dependant on the material being tested. For all the materials investigated in this study, three samples were taken of each type of the material and cataloged with a number. A minimum of 100 grams was required for the SPLP procedure, thus sample weights were kept to 100 grams to reduce the number of variables affecting the results of this study. The materials requiring only weighing before testing include all of the aggregate, Class F fly ash, bottom ash, crushed concrete, RAP, and RCP.

Before cement, Class C fly ash, and lime samples were measured, 300 grams of these materials were mixed with deionized water to make hardened cement, fly ash, or lime samples. The purpose of this procedure is to mimic the hydration process as it occurs during construction and maintenance projects. A water/cement ratio of 0.5, and 0.3 was used for the cement and class C fly ash, respectively. The w/c ratio was 1.15 for the lime samples. The deionized water was not added to the slurry lime sample, because the lime is already mixed with water. Samples were weighed and mixed in plastic cups marked with the sample identification number and the samples cured in the cups for 28 days. Samples were watered for the first 7 days of curing using deionized water. Three hundred grams of the material was used so that after crushing, enough material remained for duplicate samples. Samples were crushed with a hammer until the sample passed a 9.5 mm standard sieve. Crushed samples were stored in Ziploc bags marked with the sample identification number until tested.

Bituminous binder samples (excluding MC-30's, RAP and rapid-cure patch mix) of 300 grams were poured into plastic cups marked with the sample identification number and frozen to form a solid mass. Most of the bituminous binders received after shipping had formed a solid; therefore, the samples were heated to a minimum temperature so that the samples would flow out of their storage containers. The bituminous samples were crushed to the smallest size possible using a hammer. The MC-30's, RAP and the rapid cure patch mix were tested as they were received and stored in their sampling containers until analysis.

Test methods

This section lists the test methods used in this project as well as the purpose of each test. The tables below show the tests performed on the materials investigated in this project.

Synthetic Precipitation Leaching Procedure (SPLP)

The purpose of the Synthetic Precipitation Leaching Procedure (SW-846 Method 1312) is to determine the mobility of organic and inorganic analytes present in liquids, soils, and wastes. Extraction fluids, related to the matrix of the material tested, are mixed with the liquids, soils and wastes for a period of 18 hours. Following extraction, the liquid extract is filtered through 0.7 μm glass fiber filter to separate the liquid extract from the solid phase material. The extraction fluid contains the inorganic and organic analytes of interest.

Metal Digestion

The purpose of metal digestions on SPLP extracts is to prepare aqueous samples for analysis by atomic absorption methods. Initially, EPA SW-846 Method 3015 (Microwave Assisted Acid Digestion of Aqueous Samples and Extracts) was to be used to prepare the samples for flame or graphite atomic absorption methods. Due to difficulties with the procedure, replacement metal digestion procedures were used.

Semi-volatile Extraction

Separatory Funnel Liquid-Liquid Extraction, EPA SW-846 Method 3510C, is a procedure for isolating organic compounds from aqueous samples. This method is applicable to the isolation and concentration of water-insoluble and slightly soluble organics in preparation of chromatographic procedures.

Waste Dilution

SW-846 Method 3580A is a solvent dilution process for non-aqueous waste samples prior to analysis. This procedure is designed for wastes containing organic chemicals at concentrations of 20,000 mg/kg and are soluble in the dilution solvent.

Atomic Absorption Spectrometry

In atomic absorption spectrometry, a detector measures the amount of absorbed light from a hollow cathode lamp to measure the concentration of metals in an aqueous sample. Absorption depends on the presence of free unexcited ground-state atom that is produced in a flame or in a furnace. The wavelength of the light beam is characteristic of the metal being determined, thus providing the concentration of metal in the sample.

Atomic absorption spectrometry is divided into two techniques: direct-aspiration (FLAA) and furnace (GFAA). The direct-aspiration technique uses a flame to dry and atomized the aqueous sample. In contrast, for the furnace technique, an aqueous sample is injected into a graphite tube, where it is evaporated to dryness, charred and atomized. The furnace technique provides lower detection values because a greater percentage of the analyte atoms is vaporized and dissociated for absorption in a tube than in a flame. Thus, for part per billion (ppb) determinations, it is necessary to use the graphite furnace.

Vapor Generation Assembly

Vapor generation techniques are widely used in many laboratories with atomic absorption instruments due to its extreme sensitivity for certain elements. Mercury has been measured for many years by the cold vapor methods where stannous chloride or sodium borohydride is used as the reducing agent. Cold vapor atomic absorption techniques are based on the absorption of radiation by mercury vapor. The mercury is reduced to its elemental state and aerated from solution in a closed system. The mercury vapor passes through an absorption cell, which is positioned in the light path of an atomic absorption spectrometer and the absorbance (peak height) is measured as a function of mercury concentration (Dominski and Shrader, 1985). In the ESL, the cold vapor generator is used with the FLAA spectrometer.

GC/MS

SW-846 Method 8270C, Semivolatile Organic Compounds By Gas Chromatography/Mass Spectrometry (GC/MS), is used to determine the concentration of semivolatile organic compounds in extracts prepared from many types of solid waste matrices, soils, and water samples. This method may be used to quantitate most neutral, acidic, and basic organic compounds that are soluble in methylene chloride. Semivolatile organic compounds are introduced into the GC/MS by injecting the sample extract into a gas chromatograph with a narrow-bore fused-silica capillary column. The GC column is programmed to separate the analytes, which are then detected with a mass spectrometer. Identification of analytes is accomplished by comparing their mass spectra with the spectra of authentic standards.

TESTING OF SAMPLED MATERIALS

The purpose of this section is to describe the procedures of the tests used in this study. The detailed steps of each study as well as any changes made to the testing procedure are listed below.

SPLP

In order to begin the leaching procedure, Method 1312, (US EPA, 1999) the appropriate extraction fluid must be determined. It is assumed that all samples are obtained from a site west of the Mississippi River, thus extraction fluid number 2 is used in this analysis. Extraction fluid number 2 is prepared using reagent water and a 60/40 sulfuric acid and nitric acid solution. The acid solution is mixed with the reagent water until the pH of the solution is 5.00 +/- 0.05. However, the deionized water initially had an approximate pH of 5.00, thus the addition of acid to adjust the pH was not necessary. A 50 L container was filled with deionized water for each tumble so that all extraction vessels were filled with the same water. Sample size reduction is required for wastes unless the solid is capable of passing through a 9.5 mm (0.37 inch) standard sieve. Particle size reduction may be accomplished by crushing, cutting or grinding the waste. The only samples requiring particle size reduction were the bituminous binders, fly ash (class C), lime and cement.

After the waste was sized and the extraction fluid was prepared, a minimum sample size of 100 grams was weighed and the weight was recorded. The amount of extraction fluid used in the procedure is a percent of the weight of the waste and the percent solids of the sample. The equation is as follows:

$$\text{Weight of Extraction Fluid} = \frac{20 \times \text{Percent solids} \times \text{Weight of waste filtered}}{100} \qquad \text{Eq-1}$$

After adding 2 liters of the extraction fluid (sample was 100 percent solid) to the extractor vessels containing the waste or soil material, the extraction vessels were closed tightly and rotated at 30 +/- 2 rpm for 18 hours. Following extraction, the liquid and solid components in the extractor were filtered through a new glass fiber filter (0.7 μm); filters were acid washed when evaluating the mobility of metals. A minimum of one blank was performed for every 20 extractions and a matrix spike was performed per waste type to monitor the performance of analytical methods and to determine if matrix interferences exist (US EPA, 1999).

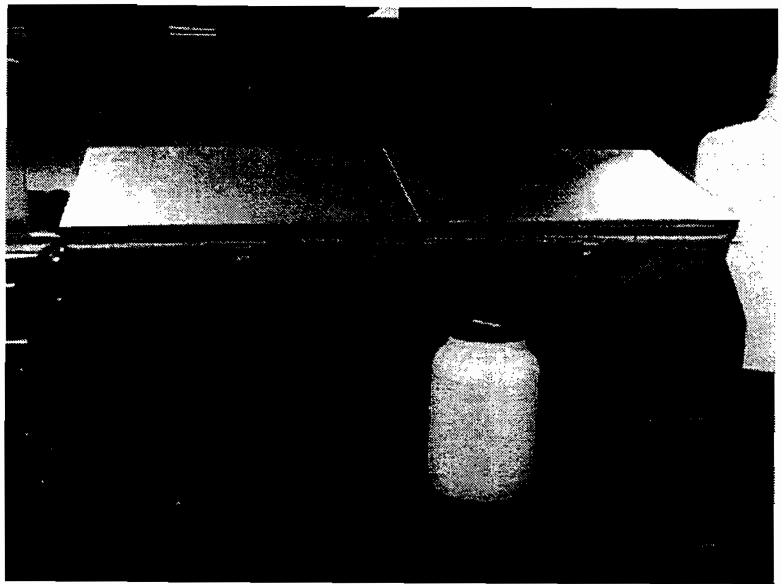
Figure 1. Extraction vessel and tumbler

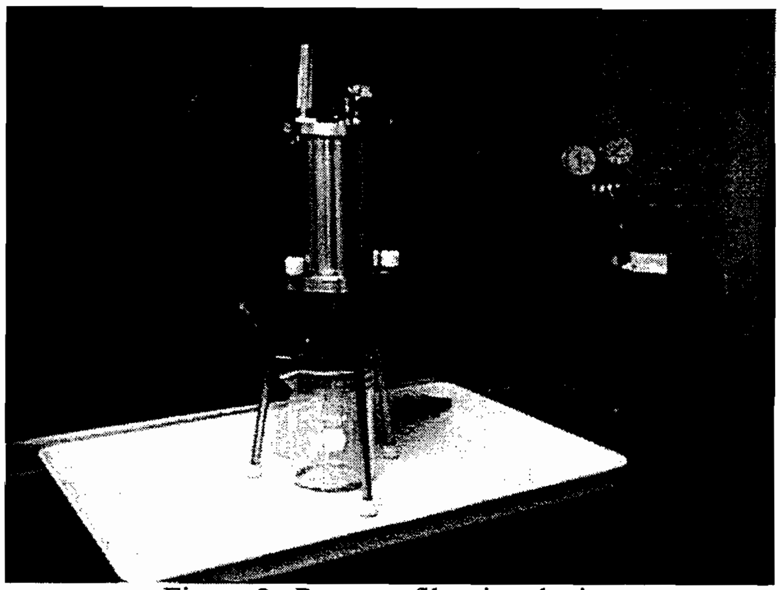
Figure 2. Pressure filtration device

A duplicate sample was prepared for each matrix type and is carried thought the analytical procedure. Blanks were carried throughout the sample preparation and analytical process to detect contamination. One sample in every 20 samples will be spiked and/or for each new sample matrix being evaluated.

Metal Digestion

Microwave digestion is used to prepare the leachate aliquots for analysis by atomic absorption spectrometry. All glassware used in the project was carefully acid washed and rinsed with reagent water. The containers were acid washed before reuse to prevent cross contamination from the vessels. All microwave digestion vessels were also acid washed between digestions.

Acid washing is a procedure in which sample containers are washed with water and placed in an acid water bath for a minimum of four hours. Nitric acid is used in the acid water bath. Acid washing is extremely important for metal analysis because metals have a tendency to settle out of solution and cling to the walls of the container in which the sample is being stored. Acid washing removes metals that have adhered to the container's walls, which reduces cross-contamination of samples (US EPA, 1999).

To begin the digestion procedure, the weight of the fluorocarbon digestion vessel, valve and cap assembly was measure and recorded. A 45 mL leachate aliquot of well shaken sample was measured in a graduated cylinder and poured into the digestion vessel. Five mL of concentrated nitric acid was added to each vessel. The caps were tightened to a uniform torque pressure of 12 ft-lbs and the vessels were weighed. Vessels were evenly distributed in the carousel. If additional samples were needed to met the manufacturers recommended number of samples to be digested, the remaining vessels were filled with 45 mL of reagent want and 5 mL of nitric acid. The vessel turntable was placed in the microwave and the procedure was initiated using the EPA Method 3015 software program loaded in the machine. Upon completion of the program, the vessels were cooled to room temperature and the weight of the each vessel was recorded. If the weight of the acid plus the weight of the sample decreased by more than 10 percent from the original weight, the sample was discarded. All samples were uncapped and vented in a fume hood before transferring the sample to an acid cleaned bottle. The digest is diluted to a known volume ensuring that the samples and standards are matrix matched (US EPA, 1999).

Initially, the microwave digestion procedure was to be used in this project. However, trouble was encountered with this procedure and it had to be replaced. The method explicitly states that if a vessel looses greater than 10 percent of its weight during the digestion procedure, the contents in the vessel must be discarded and the process repeated. During countless attempts to digest the SPLP samples, approximately 50 percent of the vessels would loose greater than 10 percent of their sample. Efforts to determine the cause of these losses failed; thus, the microwave digestion procedure was replaced.

Six digestion procedures were necessary to replace the microwave digestion procedure; they are: Method 3010, acid digestion of aqueous samples and extracts for total metals for analysis by FLAA Spectroscopy; Method 3020A, acid digestion of aqueous samples and extracts for total metals for analysis by GFAA Spectroscopy; and method 7760A, which describes the digestion procedure for the analysis of silver by direct aspiration (FLAA). Method 3005 was used for the digestion of antimony in extracts. Antimony is easily lost by volatilization in hydrochloric acid media, which required the use of an additional digestion procedure. Samples analyzed for arsenic and selenium were analyzed with a different digestion procedure as stated in Method 7060 and Method 7740, respectively. These methods are identical, thus for each sample this procedure was followed once and the extract was analyzed for selenium and arsenic. Mercury required a separate diegestion procedure, which was Method 7470A, Mercury in Liquid Waste (Manual Cold-Vapor Technique). Synopses of the digestion procedures are provided below.

For each sample, six digestion procedures were performed on the SPLP extracts. The digests were stored in their own container and the label on the container showed the date the digest was performed, the sample identification numbers, and the extraction procedure performed. All digested extracts were refrigerated until analyzed by the corresponding and appropriate analytical method.

The digestion procedures contained the following general procedure. A representative sample of the filtered SPLP extract was poured into a beaker and 3 mL of nitric acid is added to the sample. The beaker is covered with a ribbed watch glass and evaporated to approximately 5 mL on a hot plate. The antimony extract is evaporated to 15 to 20 mL, diluted to its original volume, and the procedure is complete. The beakers are cooled and an additional volume of nitric acid is added to the sample, which is evaporated to approximately 3 mL. At this point the digestion process, the procedures change and either hydrochloric acid or water is added to the samples. A reflux reaction is allowed to occur. Upon completion of the digestion procedure, the volume of the digested extract is adjusted to the initial volume using water. Approximately three to four hours are required to perform the extraction procedures and four samples may be digested at a time, which is the maximum amount of beakers that may be placed on the hot plates.

For selenium and arsenic, the digestion procedure, Method 7740/7060A, (US EPA, 1999) is similar to the other metal digestion procedures; however, hydrogen peroxide and nitric acid are added to the sample, which is heated for 1 hour at 95°C or until the volume is slightly less than 50 mL. A 5 mL samples was mixed with 1 mL of 1% nickel nitrate solution and diluted to 10 mL. The resultant 10 mL samples was ready for analysis.

In order to be sure that all steps in the digestion procedures were completed, a checklist was developed for each digestion procedure. A check is used to signify that the digestion procedure step is completed. The sheets contain the sample identification number, which beaker numbers (beakers are labeled 1 through 4), and the date the digestion was performed. These sheets are kept as records to the digestion of the samples are completed.

Semi-volatile Extraction

This procedure, Method 3510 (US EPA, 1999), was used to isolate semi-volatile organics compounds from aqueous samples using methylene chloride. One liter of SPLP extract was acidified so that the pH is less than 2 and added to a separatory funnel. Next, 60 mL of methylene chloride was added to the liter of sample and shaken for 2 minutes. The sample-methylene chloride mixture was vented periodically to prevent excessive pressure build up. The sample was allowed to set for approximately 10 minutes and the methylene chloride was drained and kept. The procedure was repeated 2 more times. Then, the pH was adjusted so that the pH was greater than 10, and the procedure was repeated three more times. At the end of the extraction, 360 mL of methylene chloride was generated. The methylene chloride was filtered using anhydrous sodium sulfate to remove any water still in the methylene chloride. Then, the methylene chloride was placed in Kudema-Danish concentrator and evaporated to 1 mL. The resultant volume was diluted to 10 mL and the sample was ready to inject into the GC/MS.

Waste Dilution

In this procedure Method 3580 (US EPA, 1999), 1.0 gram (weighed to the nearest 0.1 gram) of the sample and the appropriate surrogate standard were added to a scintillation vial. The sample was diluted to 10 mL and 2 grams of anhydrous sodium sulfate (which was cleaned with methylene chloride) was added to each vial to remove any water present in the sample. The samples were capped and shaken for 2 minutes. A disposable Pasteur pipette was packed with glass wool plugs that have been cleaned with methylene chloride. The extract was filtered through the glass wool and 5 mL of the extract was collected for analysis.

The waste dilution procedure was used for the MC-30 compounds, which are volatile asphaltic compounds. Analysis of the MC-30 compounds by SPLP was not possible because the sample was not a solid or an aqueous liquid. Sample preparation was believed to be best performed using the waste dilution method and the concentrations of the semi-volatiles tested will be in mg/kg.

Atomic Absorption Spectrometry

FLAA

The machine detection limits were used to determine which machine would be appropriate to use to for testing each metal. The metals analyzed using direct-aspiration atomic absorption spectrometry were aluminum, barium, copper, manganese, silver, and zinc. Barium and aluminum required the addition of potassium chloride to the metal digestion (Method 3010) (US EPA, 1999) to reduce interferences from other metals in the sample. The resultant potassium chloride concentration was 2000 mg/L.

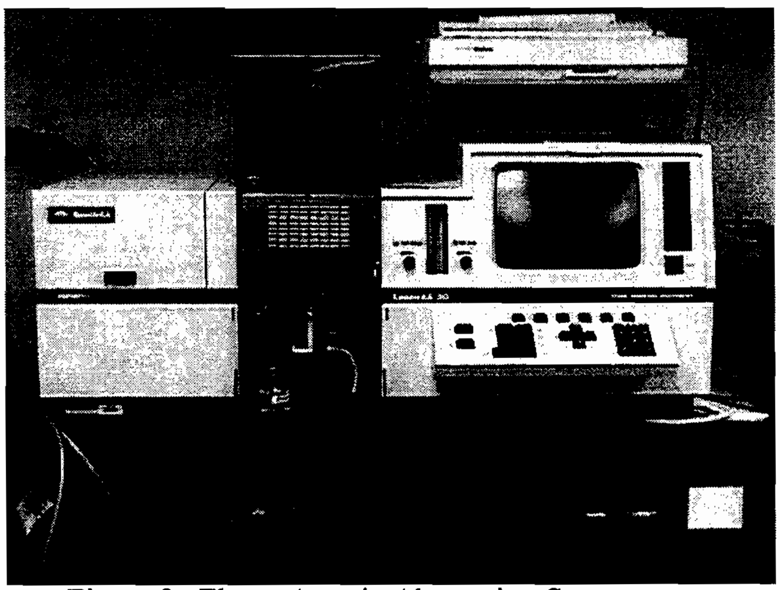

Figure 3. Flame Atomic Absorption Spectrometer

In order run the FLAA, the machine must be set up for each metal. First of all, the lamp for which the sample aliquot was to be sampled must be in the lamp turret. Then, the operating wavelength and slit width must be manually adjusted. This was accomplished by turning the wavelength dial and the slit width dial to the appropriate settings. The slit width and wavelength are predetermined by the manufacture for each metal (Varian, 1989). A concentration range is associated with each wavelength. The wavelengths used in this study were identified by using the concentration results in the literature review and choosing the most appropriate wavelength, or in some cases trial and error.

Once the wavelength and slit width are set, the machine was optimized to ensure the machine is working at optimum conditions. Then the machine was calibrated using standards in the concentration range at which the concentration of the metals in the sample was suspected. Once the machine was calibrated, the samples were ready to be analyzed. To ensure the machine was still calibrated, standards were periodically run as samples to see if the concentration reported by the instrument was the value of the standard. The FLAA was used to report concentrations in the part per million (ppm) range.

GFAA

The graphite furnace technique was used to determine the concentration of metals in liquids when low concentrations are necessary. A single standard was made that the autosampler uses to mix the calibration points. Samples were loaded into 2-mL sample cups in the autosampler. The autosampler extracts the sample and injects the sample into the graphite tube. Two graphite tubes, partition tube and the plateau tube, were used to perform the analysis and the type of tube used depends on the furnace parameters and method performed. In this project, the partition tube was used most frequently and the furnace parameters are set up to Varian's specifications. For cadmium and thallium, a plateau tube was used to because of difficulties from using the partition tube. For these metals, the furnace parameters were set up as described in a paper published by Varian (Beach, 1988) or their manual for graphite tube atomizers (Rothery, 1988).

Figure 4. Graphite Furnace Atomic Absorption Spectrometer

Vapor Generation Techniques

This technique uses the FLAA machine with the Vapor Generation Assembly without using a flame and is applicable for analyzing mercury in aqueous wastes (Method 7470A). The same procedure was used to prepare the FLAA for analysis, but a glass tube was attached to the burner and the lamp was aligned so that the light passes through the tube where the mercury vapor is located.

The standard and sample preparation procedures required the addition of many chemicals to the samples and standards. Standards that will be used to calibrate the machine are dilutions of the store-bought standards. All sample and standard preparation is performed in BOD bottles; 100 mL of sample and standard was placed into a BOD bottle. Next, 5 mL of sulfuric acid and 2.5 mL of nitric acid was added to the each bottle and mixed thoroughly. Then, 15 mL of potassium permanganate solution was added to each BOD bottle and allowed to stand a minimum of 15 minutes. The potassium permanganate solution changed the color of the samples and standards to purple. If the color still persisted after 15 minutes, then 8 mL potassium persulfate was added to the samples and standards and the samples a heated at 95°C for 2 hours. Samples are allowed to cool and then 6 mL of sodium-chloride hydroxylamine hydrochloride to decolorize the solutions by precipitating the manganese. When the solution was completely decolorized, 5 mL of stannous chloride was added to each sample and standard. The sample was now ready to be analyzed.

GC/MS

The hardware used for the semivolatile analysis included a Hewlett Packard 5972 series mass selective detector, and a Hewlett Packard 5890 series II gas chromatograph equipped with an autosampler. As suggested by EPA method 8270C (US EPA, 1999), a 30 m x 0.32 mm silicone-coated fused silica capillary column was used, and helium was selected as the carrier gas.

The injector temperature was maintained at 300°C and the detector temperature was held at a constant 280°C for the duration of the analysis. The initial oven temperature was held at 40°C for the first 4 minutes of analysis (as specified by the method), and increased at a rate of 6°C/min until the oven reached a final temperature of 300°C. The oven temperature was held constant at 300°C for 10 minutes before being cooled for the next sample analysis. The time to analyze one sample was approximately 1 hour.

The solvent delay was set at 6 minutes to allow sufficient time for the methylene chloride to prevent unnecessary wear on the filament component of the mass spectrometer. The autosampler was programmed to perform 1 sample wash, 2 sample pumps, inject a sample volume of 1 to 2 μL, and rinse with methylene chloride 3 times before injecting the next sample.

Before testing could begin, an air and water check and autotone were done to ensure the machine was working within its physical parameters. Then, the GC/MS was calibrated using standards of known concentration. To initiate analysis, the air air and water check and autotune were performed. A calibration check mix was run as a sample to determine if the machine was still calibrated, then samples would be analyzed. After 20 samples or once during a 24-hour period, the machine was autotuned and an air and water check was performed to check the machines' performance. Also, the calibration check mix of known concentration was tested again to ensure the machine was still calibrated. Upon completing the samples the calibration check was sampled again to verify the machine was still in calibration.

TESTING RESULTS

The results of this project are provided according to the type of analysis performed. In the metal analysis section, the results for each material type tested will be provided. The semi-volatile organic compounds (semi-VOCs) section will provide the results for the materials analyzed for semi-VOCs. The analysis of the matrix materials is provided separately. In this section, only the metal and semi-VOC concentrations detected in the material leachate that are greater than the RRS2 value will be discussed. However, the results for all analysis are presented in Appendix B.

Metals

The materials analyzed for metals are aggregate (limestone, caliche, sandstone, siliceous gravel, siliceous sand, and LRA), cement (Type I, II, and I/II), Class C fly ash, Class F fly ash, bottom ash, lime (Type A,B, and C), RAP, and RCP. The materials were analyzed for metals listed in Table 8. The metal results for each material are provided below. If a metal is not listed in the following tables for the material type analyzed, then the sample concentrations did not exceed RRS2 values. Thus, only the metal concentrations that exceeded RRS2 are provided below.

The detection limits used in this project were based on Texas Risk Reduction Standard 2 (RRS2) as provided in 30 TAC 335, Subchapter S, which is specified by DMS-11000, "Guidelines for Evaluating and Using Nonhazardous Recyclable Materials (NRMs) in TxDOT Projects" (TxDOT, 1999). These values were used as the detection limit to determine if the material leachate concentration exceeds the values specified in this document. Hence forth, the values provided in Subchapter S will be referred to as the RRS2 value. Table 10 provides a list of all the metals analyzed and it's corresponding RRS2 value.

Table 10. RRS2 values (30 TAC 335, Subchapter S)

Metal	RRS2 (μg/L)	Metal	RRS2 (μg/L)
Aluminum	24000	Mercury	2
Antimony	6	Manganese	1100
Arsenic	50	Molybdenum	120
Barium	2000	Nickel	100
Beryllium	4	Selenium	50
Cadmium	5	Silver	120
Chromium	100	Thallium	2
Cobalt	1500	Vanadium	26
Copper	1300	Zinc	7300
Lead	15		

Limestone

Limestone was analyzed for all metals listed in Table 8. Limestone samples exceeded the RRS2 values for antimony, lead, and mercury. As seen in Table 11, the average concentration for these metals is only slightly higher than the RRS2 value. Two of the four limestone samples had antimony concentrations exceeding RRS2; and the average antimony concentration is 7.5 μg/L in the limestone leachate. Three of the four limestone samples had detectable lead concentrations greater than RRS2. The average lead concentration is 15.87 μg/L, which is only slightly higher than 15 µg/L. The limestone samples analyzed for mercury had an average concentration of 9.75 µg/L, which exceeds the RRS2 value of 2 µg/L.

Table 11. Results for Limestone

Metal	Number Samples	Number Exceedences	Concentration (µg/L)		
			Average	Std. Dev.	RRS2
Antimony	4	2	8.43	4.16	6
Lead	4	3	15.87	7.27	15
Mercury	4	2	9.75	11.22	2

Siliceous Gravel

Siliceous gravel exceeded RRS2 for antimony, barium, lead, nickel, and mercury. Table 12 contains the analytical results for siliceous gravel for these metals. The only metals having an average concentration greater than the RRS2 value in siliceous gravel are antimony, barium, and mercury. The other metals presented in Table 12 had average concentration values less than the RRS2 values.

Table 12. Results for Siliceous Gravel

Metal	Number Samples	Number Exceedences	Concentration (µg/L)		
			Average	Std. Dev.	RRS2
Antimony	4	1	7.27	3.88	6
Barium	4	1	2007	13.33	2000
Lead	4	1	13.94	5.85	15
Mercucy	4	2	15.00	15.10	2
Nickel	4	1	69.52	30.56	100

Sandstone

Sandstone samples exceeded RRS2 metal concentrations for antimony, lead, and mercury. The number of exceedences and average detected concentration is presented in Table 13. Despite having samples exceeding RRS2, only antimony and mercury had average concentrations greater than RRS2.

Table 13. Results for Sandstone

Metal	Number Samples	Number Exceedences	Concentration (µg/L)		
			Average	Std. Dev.	RRS2
Antimony	2	1	6.26	1.77	6
Lead	2	1	12.53	4.86	15
Mercucy	2	1	11.81	13.90	2

Siliceous Sand

Only one metal had sample concentrations greater than RRS2. Antimony had three values exceeding RRS2, and the average antimony concentration is 13.03 μg/L. The RRS2 value for antimony is 6 μg/L. Table 14 contains the results of the siliceous sand analysis for antimony.

Table 14. Results for Siliceous Sand

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	**Std. Dev.**	**RRS2**
Antimony	4	3	13.03	5.41	6

Caliche

Table 15 provides the results of the caliche analysis. Average metal concentrations of antimony exceeded RRS2.

Table 15. Results for Caliche

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	**Std. Dev.**	**RRS2**
Antimony	2	2	13.07	5.01	6

LRA

For LRA, four metals had sample concentrations exceeding RRS2 values; those metals are antimony, lead, nickel, and mercury. Table 16 presents the results of the metal analysis of LRA for metals having samples that exceed RRS2. Only the average mercury sample concentration exceeded the RRS2 values. The rest of the average values were less than RRS2 standards for the metal analyzed.

Table 16. Results for LRA

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	**Std. Dev.**	**RRS2**
Antimony	4	1	5.90	1.81	6
Lead	4	1	12.87	4.11	15
Mercury	1	1	19.82	NA	2
Nickel	4	1	86.10	51.87	100

Fly Ash, Class F

Six metals analyzed in Class F fly ash had sample concentrations exceeding RRS2 metal concentrations; those metals are antimony, barium, chromium, lead, nickel, and selenium. Table 17 provides the results of the class F fly ash metal analysis. For the metals listed in Table 17, all of the average metal concentrations exceeded RRS2. The average lead concentration detected in the class F fly ash was15.61 μg/L, which is only slightly above the RRS2 value of 15 μg/L.

Table 17. Results for Class F Fly Ash

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	3	3	20.46	12.43	6
Barium	3	1	2281	486.0	2000
Chromium	3	2	196.2	101.1	100
Lead	3	1	15.61	5.58	15
Nickel	3	1	78.70	39.48	100
Selenium	3	2	115.5	129.3	50

Fly Ash, Class C

Six metals had samples with concentrations detected above RRS2 in the class C fly ash samples. Those metals are antimony, barium, chromium, lead, mercury, and selenium. All of the class C fly ash samples analyzed for aluminum, antimony, and molybdenum had concentrations greater than the RRS2 value; therefore, the average sample concentration for these metals in class C fly ash exceeds RRS2 values.

Table 18. Results for Class C Fly Ash

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	4	4	10.39	2.50	6
Barium	4	2	2167	237.0	2000
Chromium	4	2	127.5	99.21	100
Lead	4	2	17.37	13.83	15
Mercury	4	2	2.57	0.88	2
Selenium	4	1	38.34	23.97	50

Cement, Type I

Three metals had sample concentration in Type I cement exceeding RRS2 concentrations; the metals are antimony, barium, and lead. The average metal concentrations of these metals in type I cement exceed RRS2 regulatory values. Table 19 presents the results of the type I cement metal analysis.

Table 19. Results for Cement, Type I

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	2	2	7.19	0.19	6
Barium	2	2	3276	48.00	2000
Lead	2	1	15.82	4.50	15

Cement, Type II

Type II cement samples analyzed for barium, chromium, lead, and nickel have metal concentrations exceeding RRS2. Table 20 presents the average metal concentration and RRS2 value for these metals. Metals having an average concentration greater than RRS2 are barium, chromium, and lead.

Table 20. Results for Cement, Type II

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Barium	3	3	3987	790	2000
Chromium	4	3	160.9	69.05	100
Lead	4	4	31.45	16.59	15
Nickel	4	2	70.7	33.8	100

Cement, Type I/II

Only two metals had sample concentrations that exceeded RRS2 values; those metals are barium and lead, and the results for these metals are provided in Table 21. All of the barium sample concentrations exceeded 2000 μg/L and the average barium concentration is 3403 μg/L. All of the lead samples analyzed have lead concentrations greater than the lead RRS2 value, which is 15 μg/L. The average lead concentration was 24.93 μg/L.

Table 21. Results for Cement, Type I/II

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Barium	3	3	3403	577.3	2000
Lead	3	3	24.93	8.36	15

Lime, Type A

Three metals had sample concentrations exceeding RRS2 values. These metals are barium, lead, and mercury. Table 22 presents the results of the metal analysis for type A lime. Type A lime samples analyzed for barium, lead and mercury have average metal concentrations exceeding RRS2. All of the barium and lead sample concentrations are greater than RRS2.

Table 22. Results for Lime, Type A

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Barium	3	3	6298	354.0	2000
Lead	3	3	61.78	13.58	15
Mercury	3	1	2.72	1.25	2

Lime, Type B

Type B lime had samples with concentrations exceeding RRS2 metal concentrations for antimony, barium, and lead. The average metal concentration and RRS2 regulatory value is presented in Table 23 for those metals. The average metal concentration for antimony, barium, and lead exceed RRS2 values. All type B lime samples analyzed for barium and lead exceeded RRS2.

Table 23. Results for Lime, Type B

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	2	1	6.12	0.50	6
Barium	2	2	5740	2386	2000
Lead	2	2	40.10	12.72	15

Lime, Type C

Metal analysis of type C lime samples indicated four metals have sample concentrations exceeding RRS2 regulatory values, and the results of the metal analysis are presented in Table 24. Antimony, barium, lead, and mercury have average metal concentrations that exceed their RRS2 regulatory concentration. All of the barium and lead samples had concentrations greater than the RRS2 regulatory value; half of the antimony samples exceeded the RRS2 value.

Table 24. Results for Lime, Type C

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	3	2	6.56	0.60	6
Barium	3	3	4659	1844	2000
Lead	3	3	39.46	15.17	15
Mercury	3	1	2.05	0.09	2

Bottom Ash

Bottom ash had one metal, antimony, in which samples exceeded RRS2 regulatory values. Only one antimony sample exceeded RRS2 and the average antimony concentration is 5.14 μg/L, which is less than 6 μg/L. The bottom ash analytical results are provided in Table 25.

Table 25. Results for Bottom Ash

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	4	1	5.14	0.25	6

RCP

Only mercury had RCP sample concentrations exceeding RRS2 standards. Table 26 presents the number of exceedences, average metal concentration and the RRS2 concentration for mercury. The average metal concentration exceeded RRS2.

Table 26. Results for RCP

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Mercury	2	1	5.29	4.65	2

RAP

RAP samples exceeded RRS2 regulatory concentrations for antimony, barium, and lead. Table 27 presents the average concentration and RRS2 value for these metals. The average barium concentration and the average lead concentration are greater than the RRS2 values; the average antimony concentration is less than RRS2.

Table 27. Results for RAP

Metal	Number Samples	Number Exceedences	Concentration (μg/L) Average	Std. Dev.	RRS2
Antimony	2	1	5.74	0.82	6
Barium	2	1	2007	9.43	2000
Lead	2	2	20.42	0.02	15

Matrix

The matrix materials analyzed in this project included Portland cement concrete, Portland cement concrete with fly ash, and Portland cement concrete with RCP. The same cement, siliceous sand, and limestone was used to make all of the concrete samples. Deionized water was also used to make these samples. The results of the metal analysis for these materials are presented below. All samples were analyzed for all the metals listed in Table 10, except copper, silver and thallium. In the other material samples analyzed, these metals were not detected above the detection limit; therefore, they were not analyzed in the matrix materials.

Portland Cement Concrete

In Portland cement concrete (PCC), only two metals had concentrations detected in the sample greater than RRS2 regulatory value. Barium concentrations detected in the PCC samples exceeded 2000 μg/L in only three of the four samples. The average barium concentration is 2335 μg/L, which exceeds the RRS2 concentration. However, the concentration of barium in the matrix material is less than the concentration of barium in cement, which was 3310 μg/L. The concentration differences in PCC to cement may be due to the fact that in the PCC mixture only a portion of the 100-gram of sample was cement compared to the cement sample, which was 100 percent cement. The barium concentrations in the siliceous sand and the limestone used to make the cement were less than the RRS2 value.

Three lead samples exceeded the RRS2 for lead, which is 15 μg/L. The average lead concentration is 72.07 μg/L, which is greater than the RRS2 of 15 μg/L. The average lead concentrations in cement, limestone, and siliceous sand leachate are 15.82, 15.87, and 8.72 μg/L, respectively. The average lead concentration in the PCC leachate is greater than the lead leachate concentrations of the material comprising the PCC sample.

Table 28. Results for Portland Cement Concrete

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Barium	4	3	2335	270	2000
Lead	4	3	72.07	92.58	15

PCC with Fly Ash

Lead, antimony and barium were detected in the PCC-fly ash samples with concentrations greater than the RRS2 regulatory values. The average lead concentration in PCC-fly ash is 34.07 μg/L and the RRS2 value is 15 μg/L. The average lead leachate concentration for cement, fly ash, limestone, and siliceous sand are 15.82, 17.37, 15.87, and 8.72 μg/L, respectively. The lead concentration of the PCC-fly ash mixture is greater than the lead concentrations of the components use to make the PCC-fly ash sample.

All PCC-fly ash samples analyzed for barium had concentrations exceeding the RRS2 value of 2000 μg/L. The average PCC-fly ash sample barium concentration was 3365 μg/L. The barium leachate concentrations in the fly ash and cement used to make the PCC-fly ash sample are 2281 and 3276 μg/L, respectively. The barium concentration in the limestone and siliceous sand samples was less than 2000 μg/L. The barium concentration of the PCC-fly ash mixture is greater than the barium concentrations of the components use to make the PCC-fly ash sample.

Two samples analyzed for antimony had concentrations exceeding RRS2 values. The average antimony concentration is 6.72 μg/L; thus the average antimony concentration is greater than RRS2. The results for the PCC-fly ash analysis is provided in Table 29. The average antimony concentration in the fly ash, cement, limestone, and siliceous sand samples are 10.39, 7.19, 7.50, and 13.03 μg/L. The reasons the average antimony PCC-fly ash sample concentration is less than the average concentration of the components used to make PCC-fly ash may be due to the dilution effect and the matrix effect. For example, the cement, fly ash limestone, and siliceous sand samples were composed of 100 grams of this material. However, the PCC-fly ash mixture contains a percentage of all the components comprising the sample. Also, antimony may have been tied up in the material matrix. Cement and fly ash are commonly used binders in stabilization and solidification processes due to their ability to bind metals and prevent leaching of the metals from the binding matrix.

Table 29. Results for Portland Cement Concrete and Fly Ash

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Antimony	4	2	6.72	2.60	6
Barium	4	4	3365	203	2000
Lead	4	4	34.07	9.71	15

PCC with RCP

RCP was added to the PCC mixture as a coarse aggregate replacement. Two metals had concentrations in PCC-RCP that exceeded the RRS2 metal concentration values. Lead concentrations exceeding RRS2 were detected in all PCC-RCP samples. The average lead concentration is 16.60 μg/L and the RRS2 value for lead is 15 μg/L. The average lead concentration in cement, RCP, and siliceous sand are 15.82, 12.90 and 8.72 μg/L, respectively. Thus, the average lead concentration in PCC-RCP sample is greater than the average lead concentrations for the components used to make the PCC-RCP sample. This trend was also observed for the PCC-fly ash sample.

All samples analyzed for barium had barium concentrations greater than 2000 mg/L, which is the RRS2 regulatory value. The average barium concentration is 2540 μg/L. The average value for barium and lead exceed the RRS2 concentration for these metals. The average barium concentration in the cement samples is 3276 μg/L. The average barium concentration in the leachate from the RCP and siliceous sand are 2000 μg/L. Therefore, the results suggest that the dilution effect may be limiting the amount of barium in the PCC-RCP leachate, because the amount of cement used in the PCC-RCP was a fraction of the total sample. Table 30 contains the results of the metal analysis of PCC-RCP.

Table 30. Results for Portland Cement Concrete and RCP

Metal	Number Samples	Number Exceedences	Concentration (μg/L)		
			Average	Std. Dev.	RRS2
Barium	4	4	2540	364.0	2000
Lead	4	4	16.60	7.03	15

Semi-volatile Organics

Asphalt was tested for all of the semi-volatiles listed in Table 30. The regulatory limits are defined by Texas Risk Reduction Standard 2 (RRS2) as provided in 30 TAC 335, Subchapter S, which is specified by DMS-11000, "Guidelines for Evaluating and Using Nonhazardous Recycled Materials (NRMs) in TxDOT Project" (TxDOT, 1999). As illustrated in Table 31, hexachlorobenzene, n-nitrosodimethylamine, and pentachlorophenol are the only compounds that might exceed the RRS2 limit. No conclusions can be made about the materials because the machine detection limit (5.00 μg/L) was greater than the RRS2 value.

<u>MC-30</u>

The results of the semi-volatile analysis of MC-30's is provided in Table 32. The concentrations are provided in mg/kg.

Table 31. Results for Semi-VOCs in Bituminous Binders

Semi-VOCs	Average Concentration (μg/L)							
	MG-30	AC-15-5T	PG 70-22	AC-3	AC-5	PG 64-22	Patch Mix	RRS2
Hexachlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.1000
N-Nitrosodimethylamine	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.0016
Pentachlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.0122

Table 32. Average Semi-VOCs Concentrations in MC-30s

Compound	Conc. (mg/kg)	Compound	Conc. (mg/kg)	Compound	Conc. (mg/kg)
N-Nitrosodimethlamine	0.100	2-Methylnaphthalene	1.749	4-Chloroaniline	0.680
2-Fluorophenol	0.108	Hexachlorocyclopentadiene	0.102	Hexachlorobutadiene	0.100
Phenol	0.199	2,4,6-Trichlorophenol	0.100	4-Chloro-3-methylphenol	0.198
Bis(2-Chloroethyl)ether	0.100	2,4,5-Trichlorophenol	0.100	Pentachlorohenol	0.154
2-Chlorophenol	0.207	2-Fluorobiphenyl	0.116	Phenanthrene	0.142
1,3-Dichlorobenzene	0.150	2-Chloronaphthalene	0.100	Anthracene	0.168
1,4-Dichlorobenzene	0.150	2-Nitroaniline	0.191	Di-n-butyl phthalate	0.100
1,2-Dichlorobenzene	0.100	Dimethyl phthalate	0.100	Fluoranthene	0.100
2-Methylphenol	0.100	Acenaphthylene	0.100	Pyrene	0.140
Bis(2-chloroisopropyl)ether	0.100	2,6-Dinitrotoluene	0.100	4-Terphenyl-D14	0.158
4-Methylphenol	0.100	3-Nitroanaline	0.100	Butylbenzyl phthalate	0.100
N-Nitrosodi-n-propylamine	0.732	Acenaphthalene	0.155	Benzo(a)anthracene	0.100
Hexachloroethane	0.806	4-Nitrophenol	0.138	Chrysene	0.100
Nitrobenzene-D5	0.680	Dibenzofuran	0.127	Bis(2-ethylhexyl)phthalat	0.100
Nitrobenzene	0.256	2,4-Dinitrotoluene	0.121	Di-n-Octyl phthalate	0.100
Isophorone	0.282	Diethyl phthalate	0.100	Benzo(b)fluoranthene	0.100
2-Nitrophenol	0.122	4-Chlorophenylphenyl ether	0.100	Benzo(k)fluoranthene	0.100
2,4-Dimethylphenol	0.100	4-Nitroaniline	0.100	Benzo(a)pyrene	0.100
Bis(2-chloroethoxy)methane	0.129	2-Methyl-4,6-dinitrophenol	0.140	Indeno(1,2,3-cd)pyrene	0.100
2,4-Dichlorophenol	0.100	4-Bromophenylphenyl ether	0.100	Dibenzo(a,h)anthracene	0.100
1,2,4-Trichlorobenzene	0.149	2,4,6-Tribromophenol	0.101	Benzo(ghi)perylene	0.100
Naphthalene	1.294	Hexachlorobenzene	0.100		

DISCUSSION

The discussion is separated due to the type of analysis performed. A discussion of the metal analysis will be presented first, followed by the discussion of the semi-volatile organic compounds (semi-VOCs) analysis. The discussion of the matrix materials is provided separately.

Metals

Table 33 provides the average detected values for aggregate, cement, lime, bottom ash, fly ash, RCP, and RAP for the metal analyzed in this project; Table 34 provides the average metal values detected in limestone, sandstone, caliche, siliceous gravel, siliceous sand, and LRA. The metals analyzed in this project include aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium and zinc. Various regulatory values are also presented to allow for a comparison between detected concentrations and regulatory values. Hazardous metal concentrations in inland tidal waters are obtained from 30 TAC 319, Subchapter B pertaining to General Regulations Incorporated into Permits. The MCL values provided in Tables 34 and 35 are obtained from 30 TAC 290, Subchapter F pertaining to Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems. The RCRA metals values are provided in 40 CFR 261.24 on Toxicity Characteristics. The practical quantitation limits (PQL) from Appendix II of 40 CFR 258 are also referred to as protective concentration limits in 30 TAC 335, Subchapter A. The human health criteria concentrations listed in Tables 33 and 34 were obtained from 30 TAC 307 0.1-0.10 pertaining to Texas Surface Water Quality Standards.

When comparing the detected metal concentrations to the hazardous metal concentrations in inland tidal waters (30 TAC Subchapter B), only the average barium and mercury concentrations exceed the regulatory values for these metals. The barium RRS2 value is greater than the hazardous metal concentration and the hazardous mercury metal concentration is greater than the RRS2 value.

The maximum concentration levels (MCLs) for many metals analyzed in this project are the same as the RRS2 regulatory values for metals having MCL concentrations. Not all of the metals had MCL concentration values. Metals having detected concentrations exceeding the MCL regulatory values are antimony, barium, chromium, mercury, nickel, and selenium.

RCRA metal concentration values are presented for arsenic, barium, cadmium, chromium, lead, selenium and silver. None of the detected metal concentrations exceed the RCRA metal concentration values.

The PQL is referred to as the protective concentration levels in 30 TAC 335, Subchapter A. The PQL (40 CFR 258, Appendix II) is the lowest detection limit, which is dependent on the method used to prepare and analyze the samples. These values typically are more restrictive than the RRS2 values. However, setting the regulatory value of these metals to the PQL would suggest that an acceptable practice in developing regulatory standards is to the regulatory values on the method and/or machine detection limit. This is indeed a false assumption; therefore, we do not suggest setting regulatory standards on the PQL.

Table 33. Metal concentrations and regulatory standards

Metals	Concentration µg/L												
	Aggregate	Cement	Lime	Bottom Ash	Fly Ash	RCP	RAP	RRS2[a]	Hazardous[b]	MCL[c]	RCRA[d]	PQL[e]	Human Hlth[f]
Aluminum	2000	2000	2000	4800	12520	2000	2000	3800	NA	NA	NA	NA	NA
Antimony	8.97	5.73	6.06	5.14	15.43	5.42	5.74	6	NA	6	NA	30	NA
Arsenic	25.00	25.00	25.00	25.00	27.95	25.00	25.00	50	100	50	5000	10	50
Barium	2001	3555	5565	2000	2224	2000	2007	2000	1000	2000	100000	20	2000
Beryllium	1.01	1.00	1.00	1.00	1.06	1.00	1.00	4	NA	4	NA	2	NA
Cadmium	1.18	1.50	1.79	1.00	1.40	1.72	1.51	5	50	5	1000	NA	5
Chromium	11.20	70.27	23.74	10.60	161.90	16.60	5.50	100	NA	100	5000	NA	100
Cobalt	100.00	100.00	100.00	100.00	100.00	100.00	100.00	220	NA	NA	NA	10	NA
Copper	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1300	500	NA	NA	10	NA
Lead	12.31	24.03	47.13	5.88	16.50	12.90	20.40	15	500	NA	5000	10	NA
Manganese	100.0	128.9	100.0	100.0	100.0	100.0	106.7	170	100	NA	NA	NA	5
Mercury	11.67	2.00	2.26	2.00	2.29	5.29	2.00	2	5	2	200	2	0.0122
Molybdenum	11.29	11.07	11.18	10.40	237.40	10.00	10.00	18	NA	NA	NA	NA	NA
Nickel	61.10	67.53	56.88	50.00	75.56	64.88	50.00	100	1000	100	NA	150	NA
Selenium	25.00	25.00	25.00	25.00	76.91	25.00	25.00	50	50	50	1000	20	50
Silver	100.00	100.00	100.00	100.00	100.00	100.00	100.00	183	50	NA	5000	10	NA
Thallium	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2	NA	2	NA	10	NA
Vanadium	37.62	25.00	25.00	57.43	205.20	25.00	25.17	26	NA	NA	NA	40	NA
Zinc	228	707	1166	100	390	1285	633	1100	1000	NA	NA	20	NA

Note: Values for aggregate, cement, lime, bottom ash, fly ash, RCP, RAP and silica fume are the average concentrations as detected.

Note: Shaded values indicate average sample values exceeding RRS2[a]

a 30 TAC 335 Subchapter S (Industrial Solid Waste and Municipal Hazardous Waste), Risk Reduction Standards

b 30 TAC 319 Subchapter B (General Regulations Incorporated into Permits), Hazardous Metals

c 30 TAC 290 Subchapter F (Public Drinking Water), Driking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems

d 40 CFR 261.24 Toxicity Characteristics

e 40 CFR 258 Appendix II, Practical Quantitation Limits; also referred to as protective concentration limits (30 TAC 335, Subchapter A)

f 30 TAC 307 0.1-0.10, Texas Surface Water Quality Standards

Table 34. Average metal concentrations and regulatory standards

Metals	Concentration µg/L											
	Limestone	Silc. Gravel	Silc. Sand	Sandstone	Caliche	LRA	RRS2[a]	Hazardous[b]	MCL[c]	RCRA[d]	PQL[e]	Human Hlth[f]
Aluminum	2000	2000	2000	2000	2000	2000	24000	NA	NA	NA	NA	NA
Antimony	8.43	6.71	13.03	6.26	13.07	5.90	6	NA	6	NA	30	NA
Arsenic	25.00	25.00	25.00	25.00	25.00	25.00	50	100	50	5000	10	50
Barium	2000	2007	2000	2000	2000	2000	2000	1000	2000	100000	20	2000
Beryllium	1.00	1.00	1.00	1.00	1.03	1.00	4.00	NA	4	NA	2	NA
Cadmium	1.75	1.06	1.00	1.14	1.00	1.11	5.00	50	5	1000	NA	5
Chromium	9.32	7.85	5.65	11.04	5.00	29.25	100	NA	100	5000	NA	100
Cobalt	100.00	100.00	100.00	100.00	100.00	100.00	1500	NA	NA	NA	10	NA
Copper	100.00	100.00	100.00	100.00	100.00	100.00	1300	500	NA	NA	10	NA
Lead	15.9	13.9	8.7	12.5	10.0	12.9	15.00	500	NA	5000	10	5
Manganese	100	100	100	100	100	100	1100	100	NA	NA	NA	NA
Mercury	9.75	15.0	NA	11.8	2.00	19.8	2.00	5	2	200	2	0.0122
Molybdenum	10.62	10.00	10.00	10.00	14.76	12.38	120	NA	NA	NA	NA	NA
Nickel	57.94	69.52	50.00	53.05	50.00	86.10	100	1000	100	NA	150	NA
Selenium	25.00	25.00	25.00	25.00	25.00	25.00	50	50	50	1000	20	50
Silver	100.00	100.00	100.00	100.00	100.00	100.00	120	50	NA	5000	10	NA
Thallium	2.00	2.00	2.00	2.00	2.00	2.00	2	NA	2.0	NA	10	NA
Vanadium	31.25	31.15	25.00	25.00	39.69	73.60	170	NA	NA	NA	40	NA
Zinc	194	359	100	552	126	100	7300	1000	NA	NA	20	NA

Note: Values for aggregate, cement, lime, bottom ash, fly ash, RCP, RAP and silica fume are the average concentrations as detected.

Note: Shaded values indicate average sample values exceeding RRS2[a]

a 30 TAC 335 Subchapter S (Industrial Solid Waste and Municipal Hazardous Waste), Risk Reduction Standards

b 30 TAC 319 Subchapter B (General Regulations Incorporated into Permits), Hazardous Metals

c 30 TAC 290 Subchapter F (Public Drinking Water), Driking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems

d 40 CFR 261.24 Toxicity Characteristics

e 40 CFR 258 Appendix II, Practical Quantitation Limits; also referred to as protective concentration limits (30 TAC 335, Subchapter A).

f 30 TAC 307 0.1-0.10, Texas Surface Water Quality Standards

Matrix Materials

Table 35 contains the average detected values for PCC, PCC-fly ash and PCC-RCP matrix samples. Only the concrete-fly ash average metal sample concentration exceeded RRS2. The PCC, PCC-fly ash, and the PCC-RCP matrix materials have an average barium and lead concentration exceeding RRS2 regulatory values.

None of the matrix materials analyzed have metal concentrations exceeding Hazardous levels as defined in 30 TAC 319 Subchapter B or RCRA values specified in 40 CFR 261.24. Only the average barium sample concentration for PCC, PCC-fly ash, and PCC-RCP samples exceeded the maximum contaminant levels as specified in 30 TAC 290 Subchapter F. Barium and mercury exceeded the human health criteria as specified in 30 TAC 307 0.1-0.10. PQL levels for barium and lead are lower than the RRS2 values; therefore, the sample concentration detected in PCC, PCC-fly ash and PCC-RCP exceeded these values. However, it is not good public policy to set regulatory values to method or machine detection limits.

Semi-volatiles

The asphalt samples were analyzed for the semi-volatile organic compounds listed in Table 9. The average concentrations are compared to the limits as provided by RRS2, RCRA, MCL, and PQL standards, if available. These limits and the average concentrations of the semi-VOCs are provided in Table 36.

As illustrated in Table 36, hexachlorobenzene, n-nitrosodimethylamine, and pentachlorophenol are the only compounds that might exceed the RRS2 limit. No conclusions can be made about the materials because the machine detection limit (5 μg/L) was greater than the RRS2 value.

RCRA regulatory limits are not provided for hexachlorobenzene or n-nitrosodimethylamine. Assuming an average concentration of 5.00 μg/L, pentachlorophenol is still well below the 100,000 μg/L RCRA limit. MCL limits are not provided for hexachlorobenzene, n-nitrosodimethylamine, or pentachlorophenol, and, thus, cannot be compared to the average concentrations determined in this analysis.

Conclusions cannot be made for hexachlorobenzene and petachlorphenol because the machine detection limit was greater than the PQL value. N-nitrosodimethylamine is below the PQL limit of 10 μg/L.

<u>MC-30</u>

The results for the MC-30s are presented in Table 32. Because of the nature of the materials and the method used to analyze the samples, there is no standard to which these values may be compared.

Table 35. Metal concentrations and regulatory standards

	Concentration µg/L								
Metals	**PCC Concete**	**Concrete/RCP**	**Concrete/Fly Ash**	**RRS2[a]**	**Hazardous[b]**	**MCL[c]**	**RCRA[d]**	**PQL[e]**	**Human Hlth[f]**
Aluminum	2000	2000	2000	24000	NA	NA	NA	NA	NA
Antimony	5.00	5.19	6.72	6	NA	6	NA	30	NA
Arsenic	25.00	25.00	25.00	50	100	50	5000	10	50
Barium	2335	2540	3365	2000	1000	2000	100000	20	2000
Beryllium	1.07	1.00	1.00	4	NA	4	NA	2	NA
Cadmium	1.00	1.00	1.09	5	50	5	1000	NA	5
Chromium	45.15	40.39	39.16	100	NA	100	5000	NA	100
Cobalt	NA	NA	NA	1500	NA	NA	NA	10	NA
Copper	NA	NA	NA	1300	500	NA	NA	10	NA
Lead	72.10	16.60	34.10	15	500	NA	5000	10	NA
Manganese	100.00	100.00	100.00	1100	100	NA	NA	NA	5
Mercury	2.00	2.00	2.00	2	5	2	200	2	0.0122
Molybdenum	10.00	10.00	10.00	120	NA	NA	NA	NA	NA
Nickel	50.00	67.85	50.00	100	1000	100	NA	150	NA
Selenium	25.00	25.00	25.00	50	50	50	1000	20	50
Silver	NA	NA	NA	120	50	NA	5000	10	NA
Thallium	NA	NA	NA	2	NA	2	NA	10	NA
Vanadium	25.00	25.00	25.00	170	NA	NA	NA	40	NA
Zinc	583	220	358	7300	1000	NA	NA	20	NA

Note: Values for aggregate, cement, lime, bottom ash, fly ash, RCP, RAP and silica fume are the average concentrations as detected.

Note: Shaded values indicate average sample values exceeding RRS2[a]

a 30 TAC 335 Subchapter S (Industrial Solid Waste and Municipal Hazardous Waste), Risk Reduction Standards

b 30 TAC 319 Subchapter B (General Regulations Incorporated into Permits), Hazardous Metals

c 30 TAC 290 Subchapter F (Public Drinking Water), Driking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems

d 40 CFR 261.24 Toxicity Characteristics

e 40 CFR 258 Appendix II, Practical Quantitation Limits; also referred to as protective concentration limits (30 TAC 335, Subchapter A)

f 30 TAC 307 0.1-0.10, Texas Surface Water Quality Standards

Table 36 Semi-VOC concentrations in bituminous binder samples

Semi-VOCs	Concentration µg/L										
	PG 64-22	PG 70-22	AC-3	AC-5	AC-15-5T	MG-30	Patch Mix	RRS2[a]	RCRA[b]	MCL[c]	PQL[d]
Acenapthene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	2190.00	NA	NA	10.00
Acenapthylene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Anthracene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	11000	NA	NA	10.00
Benzo(a)anthracene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Benzo(a)pyrene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Benzo(b)fluoranthene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Benzo(ghi)perylene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Benzo(k)fluoranthene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Bis(2-chloroethoxy)methan	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Bis(2-chloroethyl)ether	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.0774	NA	NA	10.00
Bis(2-chloroisopropyl)ether	5.00	5.00	5.00	5.00	5.00	5.00	5.00	12.20	NA	NA	10.00
Bis(2-ethylhexyl)phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	6.08	NA	NA	10.00
4-Bromophenolphenyl ethe	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Butylbenzene phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	NA
4-Chloroaniline	5.00	5.00	5.00	5.00	5.00	5.00	5.00	146.00	NA	NA	20.00
4-Chloro-3-methylphenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	5.00
2-Chloronapthalene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	2920.00	NA	NA	10.00
2-Chlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	183.00	NA	NA	5.00
4-Chlorophenylphenyl ethe	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Chyrsene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Dibenzo(a,h)anthracene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Dibenzofuran	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
1,2 Dichlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	600.00	NA	NA	2.00
1,3 Dichlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	600.00	NA	NA	5.00
1,4 Dichlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	75.00	7500.00	NA	2.00
2,4-Dichlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	110.00	NA	NA	5.00
Diethyl phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	5.00
2,4 Dimethylphenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	730.00	NA	NA	5.00
Dimethyl phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	5.00
Di-n-butyl phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	3650.00	NA	NA	5.00
Di-n-octyl phthalate	5.00	5.00	5.00	5.00	5.00	5.00	5.00	730.00	NA	NA	10.00

2,4-Dinitrotoluene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	130.00	NA	0.20
2,6-Dinitrotoluene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	0.10
Fluoranthene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1460.00	NA	NA	10.00
Hexachlorethane	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	0.50
Hexachlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.10	NA	NA	0.50
Hexachlorobutadiene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	10.90	500	NA	5.00
Hexachlorocyclopentadiene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	5.00
Indoeno(1,2,3-cd)pyrene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Isophorone	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
2-Methyl-4,6-dinitrophenol	5.00	5.00	5.00	5.00	5.00	5.00	8.30	NA	NA	NA	NA
2-Methylnapthalene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
2-Methylphenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
4-Methylphenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Naphthalene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1460.00	NA	NA	10.00
2-Nitroaniline	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	50.00
3-Nitroaniline	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	50.00
4-Nitroaniline	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	50.00
Nitrobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	18.3	NA	NA	10.00
2-Nitrophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	5.00
4-Nitrophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
N-Nitrosodimethylamine	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.00167	NA	NA	10.00
N-Nitrosodi-n-propylamine	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.0122	NA	NA	10.00
Pentachlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	100000	NA	5.00
Phenanthrene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	NA	NA	NA	10.00
Phenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	2190	NA	NA	1.00
Pyrene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1100	NA	NA	10.00
1,2,4-Trichlorobenzene	5.00	5.00	5.00	5.00	5.00	5.00	5.00	70.00	NA	70.00	10.00
2,4,5-Trichlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	3650	400000	NA	10.00
2,4,6-Trichlorophenol	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.74	2000	NA	5.00

Note: Values for aggregate, cement, lime, bottom ash, fly ash, RCP, RAP and silica fume are the average concentrations as detected.

a 30 TAC 335 Subchapter S (Industrial Solid Waste and Municipal Hazardous Waste), Risk Reduction Standards, GW values

b 40 CFR 261.24 Toxicity Characteristics

c 30 TAC 290 Subchapter F (Public Drinking Water), Driking Water Standards Governing Drinking Water Quality and Reporting

d 40 CFR 258 App. II, Practical Quantitation Limits; also referred to as protective concentration limits (30 TAC 335, Subchapter A)

RECOMMENDATIONS

After reviewing the results of the traditional construction and maintenance material analysis generated during the testing phase of this project and comparing these results to many regulatory values, recommendations have been developed for determining the environmental applicability of using recycled materials in TxDOT construction and maintenance operations. It is recommended that leachate from SPLP procedure for recycled materials for the metals analyzed be equivalent to the RRS2 concentration or the average detected concentration plus one standard deviation for the component analyzed based on the material it is replacing. For example, if someone is proposing using a nonhazardous recycled material (NRM) as an aggregate replacement, then for the metals analyzed, the metal concentrations in the SPLP leachate should not exceed RRS2 value or the recommended value (average sample concentration plus one standard deviation). For barium, the average SPLP leachate concentration plus one standard deviation should be less than 2004 μg/L (the recommended value), which is greater than the RRS2 value of 2000 μg/L.

Table 37 to Table 43 contains the recommended regulatory concentration for metals analyzed based on the type of material. Each table contains the recommended regulatory value, method used to determine the regulatory value and the RRS2 concentrations for each metal analyzed. The column titled "Recommended" is the values recommend to be used as a regulatory guideline for the material of interest. The "Method" column shows how the "Recommended" column was developed. The last column provides the RRS2 concentration for each metal investigated.

For materials analyzed for semi-VOCs, it is recommended that the concentration of the materials analyzed be less than the RRS2. For RRS2 values for the semi-VOCs analyzed in this study, please refer to RRS2. Thus, a table has not been included for RRS2 values of semi-VOCs.

Table 37. Recommended Values for Aggregate (μg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	11	7.95+2.72	6
Arsenic	50	RRS2	50
Barium	2004	2001.00+2.65	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	100	RRS2	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	15	RRS2	15
Manganese	1100	RRS2	1100
Mercury	18	11.84+5.92	2
Molybdenum	120	RRS2	120
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

Table 38. Recommended Values for Cement (μg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	7	5.73+1.26	6
Arsenic	50	RRS2	50
Barium	3935	3555.33+379.19	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	149	70.27+78.48	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	32	24.07+7.85	15
Manganese	1100	RRS2	1100
Mercury	2	RRS2	2
Molybdenum	120	RRS2	18
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

Table 39. Recommended Values for Lime (μg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	7	6.01+0.61	6
Arsenic	50	RRS2	50
Barium	6399	5565.67+833.29	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	100	RRS2	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	60	47.11+12.71	15
Manganese	1100	RRS2	1100
Mercury	3	2.26+0.40	2
Molybdenum	120	RRS2	120
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

Table 40. Recommended Values for Bottom Ash (μg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	6	RRS2	6
Arsenic	50	RRS2	50
Barium	2000	RRS2	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	100	RRS2	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	15	RRS2	15
Manganese	1100	RRS2	1100
Mercury	2	RRS2	2
Molybdenum	120	RRS2	120
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

Table 41. Recommended Values for Fly Ash (µg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	23	15.43+7.12	6
Arsenic	50	RRS2	50
Barium	2305	2224+80.61	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	210	161.85+48.58	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	18	16.49+1.24	15
Manganese	1100	RRS2	1100
Mercury	3	2.29+0.40	2
Molybdenum	314	237.36+76.59	120
Nickel	100	RRS2	100
Selenium	131	76.92+54.56	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	323	205.20+117.95	170
Zinc	7300	RRS2	7300

Table 42. Recommended Values for RCP (µg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	6	5.42+0.59	6
Arsenic	50	RRS2	50
Barium	2000	RRS2	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	100	RRS2	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	15	RRS2	15
Manganese	1100	RRS2	1100
Mercury	10	5.29+4.65	2
Molybdenum	120	RRS2	120
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

Table 43. Recommended Values for RAP (μg/L)

Metal	Recommended Value	Method (Avg+SD)	RRS2
Aluminum	24000	RRS2	24000
Antimony	7	5.74+0.82	6
Arsenic	50	RRS2	50
Barium	2000	RRS2	2000
Beryllium	4	RRS2	4
Cadmium	5	RRS2	5
Chromium	100	RRS2	100
Cobalt	1500	RRS2	1500
Copper	1300	RRS2	1300
Lead	20	20.42+0.02	15
Manganese	1100	RRS2	1100
Mercury	2	RRS2	2
Molybdenum	120	RRS2	120
Nickel	100	RRS2	100
Selenium	50	RRS2	50
Silver	120	RRS2	120
Thalium	2	RRS2	2
Vanadium	170	RRS2	170
Zinc	7300	RRS2	7300

CONCLUSION

The purpose of this report is to document the findings of Project Number 7-4974, "Environmental Assessment of Traditional Construction and Maintenance Materials". A literature review was conducted to determine the environmental impacts of traditional construction and maintenance materials. A survey of other states' DOT and environmental agencies indicated that other states have not investigated the environmental impacts of traditional materials nor has their use been environmentally regulated.

A sampling plan was used to determine the materials and the material suppliers that would be investigated in this project. The materials investigated in this project include aggregate (limestone, sandstone, caliche, siliceous gravel, siliceous sand, and LRA), cement, bituminous binders, fly ash, bottom ash, lime, RAP, and RCP. The bituminous binders investigated include AC-3, AC-5, PG-64-22, PG 70-22, AC-15-5T, MG-30, MC-30, and a rapid cure patch mix. Portland cement concrete matrix samples, containing fly ash or RCP, were tested to evaluate how a matrix affected the leaching behavior of the materials tested.

The analysis of the materials investigated was divided into two categories: metal analysis and/or semi-volatile organic compound analysis. Materials investigated for metals include aggregate, cement, fly ash, bottom ash, lime, RCP, RAP, and the PCC matrix materials. The semi-VOC analysis was performed on the bituminous binder samples and RAP.

The experimental results for the metal analysis differs greatly depending on the material investigated. Detection limits were based on values provided in DMS 11000, "Guidelines for Evaluating and Using Nonhazardous Recyclable Materials (NRMs) in TxDOT Projects" (TxDOT, 1999). Generalizations cannot be made for the metal analysis for all the materials investigated.

All but three of the semi-VOCs analyzed (excluding MC-30 samples) had leachate concentration values less than the RRS2 value. However, due to the limits of the machine, the detection limit was greater than the RRS2 value for hexachlorobenzene, n-nitrosodimethylamine, and pentachlorophenol; therefore, conclusions can not be made for these compounds

As part of the scope of this project, recommendations were developed for the use of recycled material. It is believed that the recommended regulatory limit for metal in the SPLP leachate should be the higher of the average sample concentration plus the standard deviation or the RRS2 regulatory value as provided in 30 TAC 335, Subchapter S. It is recommended that for materials analyzed for semi-volatiles meet the RRS2 criteria.

WORK CITED

Beach, L.M. 1988. "Varian SpectrAA Zeeman Graphite Furnace Methods for Environmental Samples," Varian Instrument Group, pp. 1-24.

Brantley, A.S. and T.G. Townsend. 1999. "Leaching of Pollutants from Reclaimed Asphalt Pavement," Environmental Engineering Science, Vol. 16, No. 2, p. 105-116.

Caltrans, 1999. ftp://trescftp.dot.ca.gov/pub/Specifications/SSPs/95-SSPs/Sec_10/22-42/.

40 CFR. 2000. Code of Federal Regulations. www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1

Church, D.A., L.Raad, and M. Tumeo. 1995. "Experimental Study of Leaching of Fly Ash," Transportation Research Record, No. 1486, p. 3-12.

Commonwealth of Pennsylvania. 1998. Pennsylvania Code, Title 25. Environmental Protection, Chapter 287.601-.652.

Delmarva Power and Light Company. 1989. Ash Utilization in Highways: Delaware Demonstration Project, Electric Power Research Institute, RP2422-3.

Deschamps, R.J. 1997. "Geotechnical and Environmental Characteristics of Atmospheric Fluidized Bed Combustion Ash and Stoker Ash," Transportation Research Record, No. 1577, p. 90-95.

Dominski, P. and D.E. Shrader. 1985. Automated Cold Vapor Determination of Mercury: EPA Stannous Chloride Methodology, No. AA-51, September, pp. 1-9.

GAI Consultants, Inc. 1989. Ash Utilization in Highways: Pennsylvania Demonstration Project, Electric Power Research Institute, RP2422-19.

Garcez, I. 1984. Investigation of Leachability of Fly Ash Enhanced Road Base Materials, M.E. Thesis, Louisiana State University, 91 pp.

Joint Cooperative Committee of the Southern California Chapter American Public Works Association and Southern Caifornia Districts, 1997. "'Greenbook', Standard Specifications for Public Works Construction, BNI Building News, Anaheim, CA, pp. 82-92.

Kansas Electric Utilities Research Program. 1989. Use of Coal Ash in Highway Construction: Kansas Demonstration Project, Electric Power Research Institute, RP2422-15.

KAR. 1999. 401 KAR 45:060, Special Waste Permit by Rule.

Kreich, A.J. 1990. Evaluation of Hot Mix Asphalt for Leachability, Heritage Research Group, Indianapolis, IN.

Kreich, A.J. 1991. Evaluation of RAP for Use as a Clean Fill, Heritage Research Group, Indianapolis, Indiana.

Kreich, A.J. 1992a. Leachability of Asphalt and Concrete Pavements, Heritage Research Group, Indianapolis, Indiana.

Kreich, A.J. 1992b. Leachability of Cold Mix Asphalts, Heritage Research Group, Indianapolis, Indiana.

Kuchibhotla, K.M. 1996. Study of Mechanical Properties of Municipal Solid Waste Fly Ash Residue and its use in Pavement Construction, M.S. Thesis, Florida State University, 238 pp.

Lindgren, A. 1996. "Asphalt Wear and Pollution Transport," The Science of the Total Environment, Vol. 189/190, p. 281-286.

Lovell, C.W., T.Ke, W.Huang, and J.E. Lovell. 1991. "Bottom Ash as a Highway Materal," Transportation Research Record, No. 1310, p. 106-116.

Mostofa, G. 1995. A Methodology to Predict Long-Term Leaching Potential of Metals From Class F Fly Ash Based on Short-Term Laboratory Tests, M.S. Thesis, Texas Tech University, 163 pp.

New York State Department of Environmental Conservation. 1998. 6 NYCRR Part 360, Solid Waste Management Facilities, Section 360-1.15.

Personal communication. 1999. Mark Schollenberger, Illinois Department of Transportation.

Personal communications. 1999. Paul Benedum, West Virginia Environmental Agency.

Personal communication. 1999. Janet Manchester, Delaware Environmental Agency.

Portland Cement Association. 1992. An Analysis of Selected Trace Metals in Cement and Kiln Dust, Portland Cement Association SP109T, Skokie, Illinois, 56 pp.

Pribanic, J.A. 1994. Environmental Considerations in the Use of Salvaged Asphalt Pavement, Federal Highway Administration, FHWA/MT-96/8110-1, 26 pp.

Rothery, E., ed. 1988. Analytical Methods for Graphite Tube Atomizers, Varian Techtron Pty. Limited, Publication No. 85-100848.

Sadecki, R.W., G.P. Busacker, K.L. Moxness. 1996. An Investigation of Water Quality Runoff from Stockpiles of Salvaged Concrete and Bituminous Paving, Minnesota Department of Transportation, MN/PR-96/31, 112 pp.

Snyder, M.B. 1995. Use of Crushed Concrete Products in Minnesota Pavement Foundations Final Report, Minnesota Department of Transportation, MN/RC-96/12, 52 pp.

30 TAC. 2000. www.tnrcc.state.tx.us/oprd/index.html.

Texas Department of Transportation. 2000. "Guidelines for Evaluating and Using Nonhazardous Recyclable Materials (NRMs) in TxDOT Projects," DMS-11000.

U.S. Environmental Protection Agency. 1999. SW-846, On-Line Test Methods for Evaluating Solid Waste Physical/Chemical Methods.

Varian, 1989. Analalytical Methods, Flame Atomic Absorption Spectrometry, Publication No. 85-100009-00.

Wisconsin Administrative Code Register. 1998. Chapter NR 500, General Solid Waste Management Requirements, September, No. 513, pp. 1-10.

APPENDIX A

The Results of Metal Analysis and Organic Compound Analysis Identified in the Literature Survey.

Table A-1: Cement

Substance	Project Location	Project Description	Material Type	Material Source	Test Method	Number of Samples	Concentration (mg/L)				
							Minimum	Average	Maximum	Background/ Reference	Detection Limit
Acenaphthene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.16 μg/L	<0.16 μg/L	<0.16 μg/L	<0.16 μg/L	0.16 μg/L
Acenaphthylene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.25 μg/L	<0.25 μg/L	<0.25 μg/L	<0.25 μg/L	<0.25 μg/L
Alkalinity as $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	6	Not Given	1700	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	5	Not Given	410	Not Given	Not Applicable	Not Given
Aluminum (Al)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	17	Not Given	98 μg/L	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	12	Not Given	63 μg/L	Not Given	Not Applicable	Not Given
Anthracene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.021 μg/L	<0.021 μg/L	<0.021 μg/L	<0.021 μg/L	0.021 μg/L
Antimony (Sb)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.003	0.013	0.063	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	0.7	2.3	4.0	Not Applicable	Not Given
Arsenic (As)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.005	0.027	0.084	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	5	19	71	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.005	<0.005	<0.005	<0.005	0.005

	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	16	Not Given	66 μg/L	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	32 μg/L	Not Given	Not Applicable	Not Given
Barium (Ba)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	35	172	767	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	91	280	1402	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<2.0	2.4	3.5	<2.0	2.0
Benzo(a)anthracene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.013 μg/L	<0.013 μg/L	<0.013 μg/L	<0.013 μg/L	0.013 μg/L
Benzo(b)fluoranthene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.029 μg/L	<0.029 μg/L	<0.029 μg/L	<0.029 μg/L	0.029 μg/L
Benzo(k)fluoranthene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.013 μg/L	<0.013 μg/L	<0.013 μg/L	<0.013 μg/L	0.013 μg/L
Benzo(a)pyrene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.023 μg/L	<0.023 μg/L	<0.023 μg/L	<0.023 μg/L	0.023 μg/L
Benzo(g,h,I)perylene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.028 μg/L	<0.028 μg/L	<0.028 μg/L	<0.028 μg/L	<0.028 μg/L
Beryllium (Be)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.0001	0.0005	0.0030	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	0.32	1.13	3.05	Not Applicable	Not Given
Bicarbonate as $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	6	Not Given	830	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	4	Not Given	190	Not Given	Not Applicable	Not Given

Boron (B)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	12	Not Given	110 µg/L	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	13	Not Given	120 µg/L	Not Given	Not Applicable	Not Given
Cadmium (Cd)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.0003	0.0019	0.0123	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluable)	79	0.03	0.34	1.12	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.02	<0.02	<0.02	<0.020	0.020
Calcium ad $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	4	Not Given	8	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	5	Not Given	7	Not Given	Not Applicable	Not Given
Carbonate as $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	6	Not Given	680	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	5	Not Given	99	Not Given	Not Applicable	Not Given
Chromium (Cr)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.07	0.54	1.54	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	25	76	422	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.050	<0.050	<0.050	0.072	0.050
	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	16	Not Given	9 µg/L	Not Given	Not Applicable	Not Given

	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	19 µg/L	Not Given	Not Applicable	Not Given
Chloride (Cl)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	15	Not Given	71	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	13	Not Given	260	Not Given	Not Applicable	Not Given
Chrysene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.041 µg/L	<0.041 µg/L	<0.041 µg/L	<0.041 µg/L	0.041 µg/L
Dibenzo(a,h)anthracene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.085 µg/L	<0.085 µg/L	<0.085 µg/L	<0.085 µg/L	0.085 µg/L
Fluoranthene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.021 µg/L	<0.021 µg/L	<0.021 µg/L	<0.021 µg/L	0.021 µg/L
Fluorene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.019 µg/L	<0.019 µg/L	<0.019 µg/L	<0.019 µg/L	0.019 µg/L
Hardness as $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	5	Not Given	33	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	6	Not Given	23	Not Given	Not Applicable	Not Given
Indeno-1,2,3-c,d pyrene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.028 µg/L	<0.028 µg/L	<0.028 µg/L	<0.028 µg/L	0.028 µg/L
Iron (Fe)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	95 µg/L	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	10	Not Given	63 µg/L	Not Given	Not Applicable	Not Given
Lead (Pb)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.002	0.009	0.029	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	1	12	75	Not Applicable	Not Given

	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.2	<0.2	<0.2	<0.2	0.20
Magnesium as $CaCO_3$	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	5	Not Given	66	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	3	Not Given	32	Not Given	Not Applicable	Not Given
Mercury (Hg)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.00010	0.00055	0.00497	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	0.00005	0.01409	0.003900	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.005	<0.005	<0.005	<0.005	<0.005
Naphthalene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.16 µg/L	0.29 µg/L	0.44 µg/L	<0.16 µg/L	0.16 µg/L
Nickel (Ni)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.06	0.11	0.17	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	10	31	129	Not Applicable	Not Given
Phenanthrene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.16 µg/L	0.35 µg/L	0.44 µg/L	<0.16 µg/L	0.16 µg/L
Potassium (K)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	16	Not Given	215	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	110	Not Given	Not Applicable	Not Given
Pyrene	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.075µg/L	<0.075µg/L	<0.075µg/L	<0.075µg/L	0.075µg/L

Selenium (Se)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.001	0.011	0.025	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	0.62	1.42	2.23	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.010	<0.010	<0.010	<0.010	0.010
Silver (Ag)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.00	0.07	0.12	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	6.75	9.20	19.90	Not Applicable	Not Given
	Heritage Research Group[b]	Route #4, Springfield, IL	Portland Cement Concrete	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.040	<0.040	<0.040	<0.040	0.04
Sodium (Na)	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	16	Not Given	370	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	260	Not Given	Not Applicable	Not Given
Suspended Volatile Solids	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	36	Not Given	2	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	28	Not Given	1	Not Given	Not Applicable	Not Given
Thallim (Tl)	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	TCLP	79	0.002	0.01	0.028	Not Applicable	Not Given
	Construction Technology Laboratories[a]	Portland Cement Association	Cement	Samples from 79 cement plants in the US and 10 in Canada	Total Recoverable (acid-soluble)	79	0.01	1.08	2.68	Not Applicable	Not Given
Total Organic Carbon	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	34	Not Given	24	Not Given	Not Applicable	Not Given

	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	29	Not Given	9	Not Given	Not Applicable	Not Given
Total Solids	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	39	Not Given	1100	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	33	Not Given	1000	Not Given	Not Applicable	Not Given
Total Suspended Solids	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	39	Not Given	3	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	32	Not Given	2	Not Given	Not Applicable	Not Given
Total Volatile Solids	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	39	Not Given	130	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	33	Not Given	88	Not Given	Not Applicable	Not Given
Vanadium	Minnesota Department of Transportation	Stockpile runoff study near Shakopee, MN	Crushed concrete (retained seive #4)	Runoff provided by rain and snow events	Not Given	16	Not Given	7 µg/L	Not Given	Not Applicable	Not Given
	Minnesota Department of Transportation	Stockpile study near Shakopee, MN	Crushed concrete (pass seive #4)	Runoff provided by rain and snow events	Not Given	14	Not Given	10 µg/L	Not Given	Not Applicable	Not Given

[a] Portland Cement Association (1992)--arithmetic

[b] Kriech (1992a)--arithmetic of measureable values

[c] Sadecki et al. (1996)

Table A-2: Fly Ash and Bottom Ash

Substance	Project Location	Project Description	Material Type	Material Source	Test Method	Number of Samples	Concentration (mg/L) Minimum	Average	Maximum	Background/ Reference	Detection Limit
Alkalinity	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	Not Given	1	Not Given	29	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	Not Given	1	Not Given	23	Not Given	Not Applicable	Not Given
Aluminum (Al)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.2	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.10	Not Given	Not Applicable	0.10
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.39	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	1.38	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	24.5	Not Given	Not Applicable	0.2
Ammonia-Nitrogen (NH_4-N)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	350.2	1	Not Given	5.0	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	350.2	1	Not Given	0.20	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.1	Not Given	Not Applicable	0.1
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	ND	Not Given	Not Applicable	Not Given
Antimony (Sb)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.063	Not Given	Not Applicable	Not Given

	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.060	Not Given	Not Applicable	0.060
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.1	Not Given	Not Applicable	0.1
Arsenic (As)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	<0.20	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized, stabilized with cement or lime		TCLP	2		0.1		Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 7060	1	Not Given	<0.010	Not Given	Not Applicable	0.01
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 7061	1	Not Given	<0.010	Not Given	Not Applicable	0.01
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	3.8 mg/kg	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.002	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.024	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.189	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	0.132	Not Given	Not Applicable	Not Given

	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.27	Not Given	Not Applicable	0.0
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.28	Not Given	0.074**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.004	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.034	Not Given	0.04**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.068	Not Given	0.084**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	0.045	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.051	Not Given	0.077**	Not Given
Barium (Ba)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	0.29	Not Given	Not Applicable	Not Given
	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	1.39	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.38	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	EP-Tox	1	Not Given	0.07	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, Unstabilized		TCLP	2	0.245	0.245	0.245	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 5% lime		TCLP	2	0.262	0.338	0.413	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 10% lime		TCLP	2	2.12	2.24	2.36	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 15% lime		TCLP	2	2.38	2.40	2.41	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 5% cement		TCLP	2	0.123	0.127	0.13	Not Applicable	Not Given

Florida State University[b]		Fly Ash, stabilized 10% cement		TCLP	2	0.302	0.309	0.316	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 15% cement		TCLP	2	0.706	0.790	0.869	Not Applicable	Not Given
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.10	Not Given	Not Applicable	Not Given
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	Not Applicable	0.01
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	2.18	Not Given	Not Applicable	0.1
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.33	Not Given	0.27**	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.18	Not Given	Not Applicable	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.28	Not Given	0.26**	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.13	Not Given	0.022**	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	0.09	Not Given	Not Applicable	Not Given

	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.14	Not Given	0.21**	Not Given
Beryllium (Be)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.0050	Not Given	Not Applicable	0.0050
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.0050	Not Given	Not Applicable	0.0050
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.1	Not Given	Not Applicable	0.1
Boron (B)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	6.14	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.25	Not Given	Not Applicable	Not Given
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	27	247	760	0.2	0.0002
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	23	238	540	1.4	0.0002
Bromide (Br-)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	300.0	1	Not Given	30	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	300.0	1	Not Given	<1.0	Not Given	Not Applicable	1.0
Cadmium (Cd)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	0.03	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized, stabilized with cement or lime		TCLP	2		0.02		Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3020, 7131	1	Not Given	<0.0050	Not Given		0.0050
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3020, 7131	1	Not Given	<0.0050	Not Given		0.0050
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	1.4 mg/kg	Not Given	Not Applicable	Not Given

	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after construction silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.02	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after construction silo ash	Coal	ASTM D 3987	1	Not Given	0.014	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	Not Applicable	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	0.08**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	0.01**	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	<0.01**	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	<0.01**	0.01
Calcium (Ca)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	590	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	22	Not Given	Not Applicable	Not Given
	Duquesne Light ...		Class F fly ash, ...		EP Toxicity ...						

	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	203.0	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	19.83	Not Given	Not Applicable	0.01
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	145.65	1328	1551.65	2.35	1.0
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	134.87	1277	1272.47	6.13	1.0
Chlorides (Cl)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	3.50	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	120	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	300.1	1	Not Given	1700	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	300.1	1	Not Given	24	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.96	Not Given	Not Applicable	Not Given
Chromium (Cr)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	0.06	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	EP-Tox	1	Not Given	0.03	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 5% lime		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 10% lime		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 15% lime		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given

Florida State University[b]		Fly Ash, stabilized 5% cement		TCLP	2	0.1	0.13	0.15	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 10% cement		TCLP	2	0.3	0.31	0.31	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 15% cement		TCLP	2	0.28	0.31	0.34	Not Applicable	Not Given
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.010	Not Given	Not Applicable	0.010
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.010	Not Given	Not Applicable	0.010
The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	28.0 mg/kg	Not Given	Not Applicable	Not Given
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.05	Not Given	Not Applicable	0.05
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.05	Not Given	Not Applicable	0.050
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.05	Not Given	Not Applicable	Not Given
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	0.2	Not Given	Not Applicable	Not Given
Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.18	Not Given	Not Applicable	0.05
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.05	Not Given	0.05**	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.04	Not Given	Not Applicable	Not Given
Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.08	Not Given	0.14**	Not Given

	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.02	Not Given	0.07**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	0.02	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.03	Not Given	0.09**	Not Given
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	56.3 ppb	518 ppb	1428 ppb	<1.0 ppb	1.0 ppb
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	16.54 ppb	550 ppb	1377.8 ppb	<1.0 ppb	1.0 ppb
Cobalt (Co)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.030	Not Given	Not Applicable	0.030
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.030	Not Given	Not Applicable	0.030
Chemical Oxygen Demand (COD)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	410.4	1	Not Given	310	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	410.4	1	Not Given	22	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	Not Given	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<5.00	Not Given	Not Applicable	5.00
Conductivity	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	Not Given	1	Not Given	8322 (mmhos/cm)	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	Not Given	1	Not Given	165 (mmhos/cm)	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	1000	Not Given	Not Applicable	Not Given

	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	900	Not Given	Not Applicable	Not Given
Copper (Cu)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	<0.1	Not Given	Not Applicable	0.1
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.03	Not Given	Not Applicable	0.1
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.59	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.020	Not Given	Not Applicable	0.020
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	606 mg/kg	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.2	Not Given	Not Applicable	0.2
Cyanide	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	Not Given	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.005	Not Given	Not Applicable	0.005

Fluoride (F)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.94	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	1.00	Not Given	Not Applicable	Not Given
Iron (Fe)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.98	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.02	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.050	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.030	Not Given	Not Applicable	0.030
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.27	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after construction silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.22	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after construction silo ash	Coal	ASTM D 3987	1	Not Given	<0.03	Not Given	Not Applicable	0.03
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.2	Not Given	Not Applicable	0.2
Lead (Pb)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	<0.08	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 5% lime		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, stabilized 10% lime		TCLP	2	0.93	1.02	1.11	Not Applicable	Not Given

Florida State University[b]		Fly Ash, stabilized 15% lime		TCLP	2	0.79	1.01	0.123	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 5% cement		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 10% cement		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
Florida State University[b]		Fly Ash, stabilized 15% cement		TCLP	2	0.1	0.1	0.1	Not Applicable	Not Given
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3020, 7421	1	Not Given	0.005	Not Given	Not Applicable	Not Given
Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3020, 7421	1	Not Given	<0.0050	Not Given	Not Applicable	0.005
The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	284 mg/kg	Not Given	Not Applicable	Not Given
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.001	Not Given	Not Applicable	Not Given
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.02	Not Given	0.02**	0.02
Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.05	Not Given	Not Applicable	Not Given

	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.02+G109	Not Given	0.05**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.02	Not Given	0.02**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	0.03	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.02	Not Given	0.05	0.02
Magnesium (Mg)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	6.5	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	1.3	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	ND	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.88	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	1.46	Not Given	Not Applicable	0.1
Manganese (Mn)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.3	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	0.020	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.27	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.05	Not Given	Not Applicable	0.05

	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.1	Not Given	Not Applicable	0.1
Mercury (Hg)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	<0.005	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 7470	1	Not Given	0.0006	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 7470	1	Not Given	<0.0003	Not Given	Not Applicable	0.0003
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.004	Not Given	Not Applicable	0.004
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.0008	Not Given	Not Applicable	0.0008
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.0004	Not Given	Not Applicable	0.0004
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.0004	Not Given	Not Applicable	0.0004
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.0005	Not Given	Not Applicable	0.0005
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.001	Not Given	<0.001**	0.001
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.001	Not Given	Not Applicable	0.001
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.001	Not Given	<0.001**	0.001
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.001	Not Given	<0.001**	0.001
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	<0.001	Not Given	Not Applicable	0.001

	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.001	Not Given	<0.001**	0.001
Molybdenum (Mo)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.3400	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.10	Not Given	Not Applicable	0.10
	The Netherlands, Feniks	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	6.6 mg/kg	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.13	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.10	Not Given	Not Applicable	0.10
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.3	Not Given	Not Applicable	0.3
Nickel (Ni)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	<0.1	Not Given	Not Applicable	0.1
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.030	Not Given	Not Applicable	0.030
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.030	Not Given	Not Applicable	0.030
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	17 mg/kg	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.11	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.04	Not Given	Not Applicable	0.10
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.1	Not Given	Not Applicable	0.1

Nitrate-Nitrogen (NO_3-N)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	300.0	1	Not Given	<0.50	Not Given	Not Applicable	0.50
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	300.0	1	Not Given	<0.05	Not Given	Not Applicable	0.050
Nitrite-Nitrogen (NO_2-N)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	300.0	1	Not Given	<0.50	Not Given	Not Applicable	0.50
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	300.0	1	Not Given	<0.05	Not Given	Not Applicable	0.050
pH	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal		1	Not Given	11.9	Not Given	Not Applicable	Not Applicable
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal		1	Not Given	12.6	Not Given	Not Applicable	Not Applicable
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW		1	Not Given	6.4	Not Given	Not Applicable	Not Applicable
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW		1	Not Given	7.2	Not Given	Not Applicable	Not Applicable
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal		1	Not Given	5.1	Not Given	Not Applicable	Not Applicable
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal		1	Not Given	7.8	Not Given	Not Applicable	Not Applicable
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	5.0	Not Given	Not Applicable	Not Applicable
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	6.9	Not Given	Not Applicable	Not Applicable
Phosphate (PO_4^{-3})	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	300.0	1	Not Given	1700	Not Given	Not Applicable	Not Applicable
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	300.0	1	Not Given	24	Not Given	Not Applicable	Not Applicable

Potassium (K)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	220	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	3.9	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	7.92	Not Given	Not Applicable	0.05
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	<1.0		39.9	<1.0	1.0
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	<1.0		31.53	2.27	1.0
Selenium (Se)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	<0.5	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	EP-Tox	1	Not Given	0.002	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized, stabilized with cement or lime		TCLP	2		0.2		Not Applicable	Not Given
	Concord, MA[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 7740	1	Not Given	<0.010	Not Given	Not Applicable	0.010
	Concord, MA[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 7740	1	Not Given	<0.010	Not Given	Not Applicable	0.010
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.002	Not Given	Not Applicable	0.002
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	0.047	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.09	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	0.028	Not Given	Not Applicable	Not Given

	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.036	Not Given	0.011**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.026	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.056	Not Given	0.055**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.177	Not Given	0.141**	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	0.103	Not Given	Not Applicable	Not Given
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	0.202	Not Given	0.189**	Not Given
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	22.9 ppb	481 ppb	2679.9 ppb	5.1 ppb	0.5 ppn
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	22.7 ppb	457 ppb	2975.9 ppb	5.1 ppb	0.5 ppb
Silicon (Si)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	2.2	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	1.2	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	22	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	1.0	Not Given	Not Applicable	Not Given
Silver (Ag)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	TCLP	1	Not Given	<0.01	Not Given	Not Applicable	Not Given
	Florida State University[b]		Fly Ash, unstabilized, stabilized with cement or lime		TCLP	2		0.12		Not Applicable	Not Given

	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.020	Not Given	Not Applicable	0.02
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.02	Not Given	Not Applicable	0.02
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.52	Not Given	Not Applicable	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	<0.01**	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	<0.01**	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	<0.01**	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	Delmarva Bottom ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Delmarva Power and Light Co.[g]	Highway ramp embankment	New Jersey stockpiled fly ash	Coal	ASTM D 3987	1	Not Given	<0.01	Not Given	<0.01**	0.01
Sodium (Na)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	28.9	Not Given	Not Applicable	Not Given

	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	1.04	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	740	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	8.1	Not Given	Not Applicable	Not Given
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	Not Given	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	43.1	Not Given	Not Applicable	1.0
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 5.6	Coal	Atomic Absorption Spectrometer	7	36.68		7297.08	12.92	2.0
	Texas Tech University[h]	Hoechst Celanese Plant, Pampa, TX	Class F fly ash, pH 10.5	Coal	Atomic Absorption Spectrometer	7	<2.00	1456	5112.04	57.96	2.0
Strontium (Sr)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	4.4	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	0.015	Not Given	Not Applicable	Not Given
Sulfate	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	284	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	1600	Not Given	Not Applicable	Not Given
Sulfide	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	<0.1	Not Given	Not Applicable	0.1
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	32	Not Given	Not Applicable	Not Given
Thallium (Tl)	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.5	Not Given	Not Applicable	0.5
Titanium (Ti)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.10	Not Given	Not Applicable	0.10
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.10	Not Given	Not Applicable	0.10

Total Dissolved Solids (TDS)	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	Not Given	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<4.00	Not Given	Not Applicable	4.00
Total Organic Carbon (TOC)	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	Not Given	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.10	Not Given	Not Applicable	0.10
Total Solids	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	448	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	4700	Not Given	Not Applicable	Not Given
Vanadium (V)	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	<0.010	Not Given	Not Applicable	0.010
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.010	Not Given	Not Applicable	0.010
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.5	Not Given	Not Applicable	0.5
Zinc (Zn)	Purdue University[a]	A.E. Stanely Manufacturing Co., Lafayette, Indiana	Class F fly ash	Indiana high sulfur coal	Indiana NWLT	1	Not Given	1.06	Not Given	Not Applicable	Not Given
	Purdue University[a]	Purdue University, AFBC	Baghouse	Indiana high sulfur coal	Indiana NWLT	1	Not Given	0.46	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash	MSW	SW846 3010, 6010	1	Not Given	0.1	Not Given	Not Applicable	Not Given
	Concord, NH[c]	Concord Reg. Solid Waste/ Resource Recovery Cooperative	Bottom ash/asphalt	MSW	SW846 3010, 6010	1	Not Given	<0.020	Not Given	Not Applicable	0.020
	The Netherlands, Feniks[d]	pavement	Bottom ash/asphalt	MSW	Diffusion test, Standtest NVN 5432	1	Not Given	707 mg/kg	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.1	Not Given	Not Applicable	Not Given

	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash	Coal	ASTM D 3987	1	Not Given	<0.005	Not Given	Not Applicable	0.01
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	0.13	Not Given	Not Applicable	Not Given
	Duquesne Light Co, Cheswick Power St.[e]	Structural fill embankment I-279	Class F fly ash, after const. silo ash	Coal	ASTM D 3987	1	Not Given	0.028	Not Given	Not Applicable	Not Given
	Jeffrey Energy Center, KS[f]	Roadbase stabilization	Class C Fly ash	Coal	EP Toxicity Test , SW846 1310	1	Not Given	<0.5	Not Given	Not Applicable	0.5

ND Non-Detect

*mg/L unless otherwise noted

**Concentration of fresh fly ash before stockpiling

[a] Deschamps (199?)

[b] Kuchibhotla (1996)--arithmetic

[c] Gress et al. (1991)

[d] Eymael et al. (1994)

[e] GAI Consultants, Inc. (1989)

[f] Kansas Electric Utilities Research Program

[g] Delmarva Power and Light Company

[h] Mostofa (1995)--arithmetic

Table A-3: Fly and Bottom Ash Groundwater and Runoff

Substance	Project Location	Project Description	Material Type	Material Source	Test Method	Number of Samples	Concentration (mg/L) Minimum	Average	Maximum	Background/ Reference	Detection Limit
Aluminum (Al)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	0.002	0.047	0.170	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	0.005	0.118	0.329	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.101	0.186	0.356	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.074	0.120	0.219	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	0.045	0.065	0.084	Not Given	Not Given
Arsenic (Ar)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.002	<0.002	<0.002	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.002	0.004	0.006	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.002	<0.002	<0.002	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.002	<0.002	<0.002	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	<0.002	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	0.002	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.002	<0.002	<0.002	Not Given	0.002

Barium (Ba)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	0.023	0.054	0.078	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	0.068	0.103	0.163	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.044	0.064	0.101	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.054	0.084	0.102	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	0.48	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	0.24	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	0.043	0.600	0.077	Not Given	Not Given
Cadmium (Cd)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.001	<0.001	0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	Not Given	Not Given

	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.001	<0.001	<0.001	Not Given	0.001
Calcium (Ca)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	5.9	11.5	19.6	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	94.0	131.0	148.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	19.6	28.3	39.2	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	4.3	7.7	10.4	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	27.0	36.0	45	Not Given	0.001
Chromium (Cr)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.001	0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.001	<0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.001	<0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.001	0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	0.01	Not Given	Not Given	0.01
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	0.002	0.002	0.002	Not Given	Not Given

Conductivity	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	76	118	205	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	866	1025	1200	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	375	415	460	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	145	182	236	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	192	256	320	Not Given	Not Given
Copper (Cu)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.002	0.006	0.010	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	0.005	0.007	0.010	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.003	0.011	0.029	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.006	0.014	0.019	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.002		0.004	Not Given	0.002
Iron (Fe)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.01	0.05	0.18	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	0.02	0.58	3.60	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.01	0.053	0.13	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.01	0.03	0.05	Not Given	Not Given

	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.01	<0.01	<0.01	Not Given	0.010
Lead (Pb)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.001	0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.001	0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.001	0.001	0.002	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.001	0.001	0.003	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	0.03	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	0.02	Not Given	Not Given	0.02
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.001		0.003	Not Given	0.001
Magnesium (Ma)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	1.3	2.3	4.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	22.6	29.2	35.5	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	10.8	13.5	16.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	4.7	8.2	9.9	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	5.0	5.8	6.6	Not Given	Not Given

Mercury (Hg)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.0005	<0.0005	<0.0005	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.0005	<0.0005	<0.0005	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.0005	<0.0005	<0.0005	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.0005	<0.0005	<0.0005	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	<0.0005	Not Given	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	<0.0005	Not Given	Not Given	0.0005
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.0005	<0.0005	<0.0005	Not Given	0.0005
pH	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	5.60	6.0	6.45	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	6.68	7.2	7.46	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	4.07	4.8	5.16	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	4.48	4.8	5.39	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	8.48	8.70	8.93	Not Given	Not Given
Selenium (Se)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.002	<0.002	0.002	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.002	0.002	0.003	Not Given	0.002

	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.007	0.012	0.014	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.002	<0.002	0.002	Not Given	0.002
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	<0.002	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	<0.002	Not Given	Not Given	0.0020
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	0.002	0.004	0.005	Not Given	Not Given
Silica (Si)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	15.9	19.1	24.8	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	14.6	25.1	40.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	16.2	20.3	25.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	5.8	9.0	10.5	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	1	2.0	3.0	Not Given	Not Given
Silver (Ag)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	<0.001	<0.001	<0.001	Not Given	0.001

	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (1.5-2.0')	Leachate	Near Well No. 2	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / soil sample (3.0-3.5')	Leachate	Near Well No. 3	EP Toxicity Test , SW846 1310	1	Not Given	<0.01	Not Given	Not Given	0.01
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	<0.001	<0.001	<0.001	Not Given	0.001
Sulfate (SO_4)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	1.0	5.3	16.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	105	129	144	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	60.0	95.0	110.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	18.0	25.0	35.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	22.0	26.0	33.0	Not Given	Not Given
Total Carbon	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	5.2	7.9	10.8	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	45.6	50.6	57.8	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	3.9	7.1	10.4	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	2.9	5.3	8.3	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	14.1	16.6	18.5	Not Given	Not Given

Total Dissolved Solids (TDS)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	39.0	76.0	107.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	519.0	665.0	751.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	226.0	276.0	325.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	103.0	125.0	154.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	21.0	18.5	16.0	Not Given	Not Given
Total Inorganic Carbon (TIC)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	4.3	5.7	8.2	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	31.8	35.9	41.8	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.8	1.4	8.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.3	0.7	1.1	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	6.7	7.0	7.3	Not Given	Not Given
Total Organic Carbon (TOC)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	5.1	7.5	8.2	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	9.5	14.7	17.9	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	2.6	5.6	8.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	2.7	4.6	7.2	Not Given	Not Given

	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	7.4	9.0	11.2	Not Given	Not Given
Total Suspended Solids (TSS)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	0.8	20	112	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	1.0	52.0	348.0	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.8	28	147	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.3	31	196	Not Given	Not Given
Zinc (Zn)	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 1	Not Given	9	0.006	0.014	0.031	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 2	Not Given	9	0.005	0.016	0.042	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 3	Not Given	9	0.099	0.118	0.154	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / groundwater monitoring	Groundwater	Well No. 4	Not Given	9	0.028	0.038	0.051	Not Given	Not Given
	Delmarva Power and Light Co.[a]	Highway ramp fly ash embankment / runoff	Runoff	Drainage ditches, near Ramp A & B	EP Toxicity Test , SW846 1310	2	0.007	0.010	0.012	Not Given	Not Given

*avgeraged over 2 year period

[a] Delmarva Power and Light Company

Table A-4: Asphalt Leaching Tests

Substance	Project Location	Project Description	Material Type	Material Source	Test Method	Number of Samples	Concentration (mg/L)* Minimum	Average	Maximum	Background/ Reference	Detection Limit
Acenaphthene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.2 µg/L	<0.2 µg/L	<0.2 µg/L	Not Applicable	0.2 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.194 µg/L	Not Given	Not Applicable	0.194 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.13 µg/L		0.14 µg/L	Not Applicable	0.13 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.16 µg/L	<0.16 µg/L	<0.16 µg/L	<0.16 µg/L	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.16 µg/L	Not Given	Not Applicable	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.16 µg/L	Not Given	Not Applicable	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.16 µg/L	Not Given	Not Applicable	0.16 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Acenaphthylene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.2 µg/L	<0.2 µg/L	<0.2 µg/L	Not Applicable	0.2 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.15 µg/L	Not Given	Not Applicable	0.15 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphalt Pavement	RAP	TCLP, SW846-3010	6	<0.20 µg/L		0.49 µg/L	Not Applicable	0.20 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.25 µg/L	<0.25 µg/L	<0.25 µg/L	<0.25 µg/L	0.25 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.25 µg/L	Not Given	Not Applicable	0.25 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.25 µg/L	Not Given	Not Applicable	0.25 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.25 µg/L	Not Given	Not Applicable	0.25 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Alkalinity (mg $CaCO_3$/L)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, Method 403	6	20	34	45	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, Method 403	6	22	36	47	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Method 403	6	22	36	43	Not Applicable	Not Given
Anthracene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.2 µg/L	<0.2 µg/L	<0.2 µg/L	Not Applicable	0.2 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.015 µg/L	Not Given	Not Applicable	0.015 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.017 µg/L	<0.017 µg/L	<0.017 µg/L	Not Applicable	0.017 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.021 µg/L	<0.021 µg/L	<0.021 µg/L	<0.021 µg/L	0.021 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	0.14 µg/L	Not Given	Not Applicable	0.021 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0. 21 µg/L	Not Given	Not Applicable	0.021 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	0.090 µg/L	Not Given	Not Applicable	0.021 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Arsenic (Ar)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.5	<0.5	<0.5	Not Applicable	0.5
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphalt Pavement	RAP	TCLP, SW846-3010	6	<0.005	<0.005	<0.005	Not Applicable	0.005
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.005	<0.005	<0.005	<0.005	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005

	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
Barium (Ba)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<10	<10	<10	Not Applicable	10
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<2.0	Not Given	Not Applicable	2.0
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	0.33	0.36	0.4	Not Applicable	0.20
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<2.0	3.2	3.7	2.9	2.0
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<2.0	Not Given	Not Applicable	2.0
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<2.0	Not Given	Not Applicable	2.0
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<2.0	Not Given	Not Applicable	2.0
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7080A	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7080A	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7080A	6	<0.5	<0.5	<0.5	Not Applicable	0.5
Benzene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50

	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Benzo(a)anthracene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.01 µg/L	<0.01 µg/L	<0.01 µg/L	Not Applicable	0.01 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.048 µg/L	Not Given	Not Applicable	0.048 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.13 µg/L		0.017 µg/L	Not Applicable	0.013 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.013 µg/L	<0.013 µg/L	<0.013 µg/L	<0.013 µg/L	0.013 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.13 µg/L	Not Given	Not Applicable	0.13 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.13 µg/L	Not Given	Not Applicable	<0.13 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.13 µg/L	Not Given	Not Applicable	<0.13 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Benzo(b)fluoranthene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.01 µg/L	<0.01 µg/L	<0.01 µg/L	Not Applicable	0.01 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.02 µg/L	Not Given	Not Applicable	0.02 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.023 µg/L	<0.023 µg/L	<0.023 µg/L	Not Applicable	0.023 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.029 µg/L	<0.029 µg/L	<0.029 µg/L	<0.029 µg/L	0.029 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.029 µg/L	Not Given	Not Applicable	0.029 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.029 µg/L	Not Given	Not Applicable	0.029 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.029 µg/L	Not Given	Not Applicable	0.029 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Benzo(k)fluoranthene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.01 µg/L	<0.01 µg/L	<0.01 µg/L	Not Applicable	0.01 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.022 µg/L	Not Given	Not Applicable	0.022 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphahlt Pavement	RAP	TCLP, SW846-3010	6	<0.017 µg/L		0.050 µg/L	Not Applicable	0.017 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.013 µg/L	<0.013 µg/L	<0.013 µg/L	<0.013 µg/L	0.013 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.013 µg/L	Not Given	Not Applicable	0.013 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.013 µg/L	Not Given	Not Applicable	0.013 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.013 µg/L	Not Given	Not Applicable	0.013 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
Benzo[ghi]perylene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Benzo(a)pyrene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.02 µg/L	<0.02 µg/L	<0.02 µg/L	Not Applicable	0.02 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.023 µg/L	Not Given	Not Applicable	0.023 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.240 µg/L	<0.240 µg/L	<0.240 µg/L	Not Applicable	0.240 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.023 µg/L	<0.023 µg/L	<0.023 µg/L	<0.023 µg/L	0.023 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.23 µg/L	Not Given	Not Applicable	0.23 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.23 µg/L	Not Given	Not Applicable	0.23 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.23 µg/L	Not Given	Not Applicable	0.23 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<0.25 µg/L	<0.25 µg/L	<0.25 µg/L	Not Applicable	0.25 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<0.25 µg/L	<0.25 µg/L	<0.25 µg/L	Not Applicable	0.25 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<0.25 µg/L	<0.25 µg/L	<0.25 µg/L	Not Applicable	0.25 µg/L
1,12,Benzoperylene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.02 µg/L	<0.02 µg/L	<0.02 µg/L	Not Applicable	0.02 µg/L
Bromide (Br-)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	<1.0	<1.0	<1.0	Not Applicable	1.00
Bromobenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

Bromochloromethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Bromoform	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Bromomethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
n-butylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

sec-butylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
n-propylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Cadmium (Cd)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.1	<0.1	<0.1	Not Applicable	0.1
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	<0.02	<0.02	<0.02	Not Applicable	0.02
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.02	<0.02	<0.02	Not Applicable	0.20
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	SW846-7080	5	<0.02	<0.02	<0.02	<0.020	0.020
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.02	Not Given	Not Applicable	0.20
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.02	Not Given	Not Applicable	0.20
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.02	Not Given	Not Applicable	0.20

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7130-31A	6	<0.005	<0.005	<0.005	Not Applicable	0.005
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7130-31A	6	<0.005	<0.005	<0.005	Not Applicable	0.005
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7130-31A	6	<0.005	<0.005	<0.005	Not Applicable	0.005
Calcium (Ca^{+2})	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	8.049	13.660	25.083	Not Applicable	1.00
Carbon Tetrachloride	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Chemical Oxygen Demand (COD)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, Method 508B	6	81	58	153	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, Mehod 508B	6	82	113	144	Not Applicable	Not Given

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Method 508B	6	82	111	144	Not Applicable	Not Given
Chloride (Cl-)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	3.367	3.509	3.883	Not Applicable	1.00
Chlorobenzene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 μg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 μg/L	Not Given	Not Applicable	50 μg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 μg/L	Not Given	Not Applicable	50 μg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 μg/L	Not Given	Not Applicable	50 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Chloroethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Chloroform	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5 μg/L	Not Given	Not Applicable	5 μg/L

	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
2-chlorotoluene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
4-chlorotoluene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Chromium (Cr)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.5	<0.5	<0.5	Not Applicable	0.5

	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	0.10	Not Given	Not Applicable	0.010
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.050		0.52	Not Applicable	0.050
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	SW846-7080	5	<0.050	<0.050	<0.050	<0.050	0.050
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.01	Not Given	Not Applicable	0.01
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7190-91	6	<0.1	<0.1	<0.1	Not Applicable	0.1
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7190-91	6	<0.1	<0.1	<0.1	Not Applicable	0.1
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7190-91	6	<0.1	<0.1	<0.1	Not Applicable	0.1
Chrysene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.1 µg/L	<0.1 µg/L	<0.1 µg/L	Not Applicable	0.1 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.017 µg/L	Not Given	Not Applicable	0.017 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.033 µg/L	<0.033 µg/L	<0.033 µg/L	Not Applicable	0.033 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.041 µg/L	<0.041 µg/L	<0.041 µg/L	<0.041 µg/L	0.041 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.041 µg/L	Not Given	Not Applicable	0.041 µg/L

	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.041 µg/L	Not Given	Not Applicable	0.041 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.041 µg/L	Not Given	Not Applicable	0.041 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 µg/L	<5.0 µg/L	<5.0 µg/L	Not Applicable	5.0 µg/L
Conductivity	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, Method 205	6	50.3	58.0	69.5	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, Method 205	6	51.20	58.2	70.2	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Method 205	6	48.7	58.10	71.6	Not Applicable	Not Given
Copper (Cu)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7210-11	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7210-11	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7210-11	6	<0.5	<0.5	<0.5	Not Applicable	0.5
Cresylic Acid	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 µg/L	Not Given	Not Applicable	30 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphalt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
Dibenzo(a,h)anthracene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.02 µg/L	<0.02 µg/L	<0.02 µg/L	Not Applicable	0.02 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.018 µg/L	Not Given	Not Applicable	0.018 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphalt Pavement	RAP	TCLP, SW846-3010	6	<0.068 µg/L	<0.068 µg/L	<0.068 µg/L	Not Applicable	0.068 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.085 µg/L	<0.085 µg/L	<0.085 µg/L	<0.085 µg/L	0.085 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.085 µg/L	Not Given	Not Applicable	0.085 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.085 µg/L	Not Given	Not Applicable	0.085 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.041 µg/L	Not Given	Not Applicable	0.085 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
Dibromochloromethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Dibromomethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,2-Dibromomethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,2-Dichlorobenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,3-Dichlorobenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,4-Dichlorobenzene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1-dichloroethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1-dichloroethene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
cis-1,2-dichloroethene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
trans-1,2-dichloroethene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,2 dichloroethylene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5 µg/L	Not Given	Not Applicable	5 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
1,1 dichloroetylene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5 µg/L	Not Given	Not Applicable	5 µg/L

	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
1,2-dichloropropane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,3-dichloropropane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1-dichloropropene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
cis-1,3-dichloropropene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
trans-1,3-dichloropropene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
2,4-Dinitrotoluene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Dissolved Oxygen (DO)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water	6	5.25	5.70	6.41	Not Applicable	Not Applicable
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP	6	5.30	5.71	6.45	Not Applicable	Not Applicable
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP	6	5.43	5.72	6.49	Not Applicable	Not Applicable

Ethylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Fluoranthene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.1 μg/L	<0.1 μg/L	<0.1 μg/L	Not Applicable	0.1 μg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.037 μg/L	Not Given	Not Applicable	0.037 μg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.068 μg/L	<0.068 μg/L	<0.068 μg/L	Not Applicable	0.068 μg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.021 μg/L	<0.021 μg/L	<0.021 μg/L	<0.021 μg/L	0.021 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.021 μg/L	Not Given	Not Applicable	0.021 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.021 μg/L	Not Given	Not Applicable	0.021 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	0.19 μg/L	Not Given	Not Applicable	0.021 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<5.0 μg/L	<5.0 μg/L	<5.0 μg/L	Not Applicable	5.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<5.0 μg/L	<5.0 μg/L	<5.0 μg/L	Not Applicable	5.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<5.0 μg/L	<5.0 μg/L	<5.0 μg/L	Not Applicable	5.0 μg/L

Fluorene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.2 µg/L	<0.2 µg/L	<0.2 µg/L	Not Applicable	0.2 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.023 µg/L	Not Given	Not Applicable	0.023 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.015 µg/L	<0.015 µg/L	<0.015 µg/L	Not Applicable	<0.015 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.019 µg/L	<0.019 µg/L	<0.019 µg/L	<0.019 µg/L	0.019 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	1.8 µg/L	Not Given	Not Applicable	0.019 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	3.4 µg/L	Not Given	Not Applicable	0.019 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	1.0 µg/L	Not Given	Not Applicable	0.019 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Floride (Fl-)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	5.43	5.72	6.49	Not Applicable	1.0
Hexachlorobenzene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L

	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Hexachlorobutadine	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Hexachloroethane	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Indeno-1,2,3-c,d pyrene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.02 µg/L	<0.02 µg/L	<0.02 µg/L	Not Applicable	0.02 µg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.021 µg/L	Not Given	Not Applicable	0.021 µg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Asphalt Pavement	RAP	TCLP, SW846-3010	6	<0.022 µg/L	<0.022 µg/L	<0.022 µg/L	Not Applicable	<0.022 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.028 µg/L	<0.028 µg/L	<0.028 µg/L	<0.028 µg/L	0.028 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.028 µg/L	Not Given	Not Applicable	0.028 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.028 µg/L	Not Given	Not Applicable	0.028 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.028 µg/L	Not Given	Not Applicable	0.028 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Isopropylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
4-Isopropyltoluene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Lead (Pb)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.5	<0.5	<0.5	Not Applicable	0.5
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.20	Not Given	Not Applicable	0.20
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.20		1.8	Not Applicable	0.20
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	SW846-7080	5	<0.20	<0.20	<0.20	<0.20	0.20
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.20	Not Given	Not Applicable	0.20
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.20	Not Given	Not Applicable	0.20
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.20	Not Given	Not Applicable	0.20
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7420-21	6	<0.010	<0.010	<0.010	Not Applicable	0.010
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7420-21	6	<0.010	<0.010	<0.010	Not Applicable	0.010
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7420-21	6	<0.010	<0.010	<0.010	Not Applicable	0.010
Magnesium (Mg^{+2})	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	<1.00	1.40	1.996	Not Applicable	1.0
Mercury (Hg)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.02	<0.02	<0.02	Not Applicable	0.02

	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.005	<0.005	<0.005	Not Applicable	0.005
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.005	<0.005	<0.005	<0.005	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
Methyl Chloride	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Methyl Ethyl Ketone	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
2-Methyl Phenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 μg/L	Not Given	Not Applicable	30 μg/L

	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
3-Methyl Phenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 µg/L	Not Given	Not Applicable	30 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
4-Methyl Phenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 µg/L	Not Given	Not Applicable	30 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<250 µg/L	<250 µg/L	<250 µg/L	Not Applicable	250 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Nickel (Ni)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7520	6	<0.1	<0.1	<0.1	Not Applicable	0.1

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7520	6	<0.1	<0.1	<0.1	Not Applicable	0.1
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7520	6	<0.1	<0.1	<0.1	Not Applicable	0.1
Naphthalene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.2 μg/L	<0.2 μg/L	<0.2 μg/L	Not Applicable	0.2 μg/L
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	0.25 μg/L	Not Given	Not Applicable	0.096 μg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.13 μg/L	0.40 μg/L	0.49 μg/L	Not Applicable	0.13 μg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	0.26 μg/L	0.37 μg/L	0.76 μg/L	<0.16 μg/L	0.16 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	4.4 μg/L	Not Given	Not Applicable	0.16 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	8.0 μg/L	Not Given	Not Applicable	0.16 μg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	14 μg/L	Not Given	Not Applicable	0.16 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 μg/L	<1.0 μg/L	<1.0 μg/L	Not Applicable	1.0 μg/L
Nitrate	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	3.276	3.42	3.57	Not Applicable	1.0

Nitrobenzene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<12 µg/L	Not Given	Not Applicable	12 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<250 µg/L	<250 µg/L	<250 µg/L	Not Applicable	250 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
Pentachlorophenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<60 µg/L	Not Given	Not Applicable	60 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<250 µg/L	<250 µg/L	<250 µg/L	Not Applicable	250 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<250 µg/L	Not Given	Not Applicable	250 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<250 µg/L	Not Given	Not Applicable	250 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<250 µg/L	<250 µg/L	Not Applicable	250 µg/L
pH	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, Method 423	6	9.47	9.55	9.7	Not Applicable	Not Applicable
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, Method 423	6	9.50	9.58	9.68	Not Applicable	Not Applicable
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Method 423	6	9.28	9.40	9.50	Not Applicable	Not Applicable
Phenanthrene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4		<0.1 µg/L		Not Applicable	Not Given

	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.033 µg/L	Not Given	Not Applicable	0.033 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.13 µg/L	0.40 µg/L	0.49 µg/L	Not Applicable	0.13 µg/L
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.16 µg/L		0.30 µg/L	<0.16 µg/L	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	1.3 µg/L	Not Given	Not Applicable	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	0.74 µg/L	Not Given	Not Applicable	0.16 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	1.1 µg/L	Not Given	Not Applicable	0.16 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<2.5 µg/L	<2.5 µg/L	<2.5 µg/L	Not Applicable	2.5 µg/L
Potassium (K^+)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	<1.0	1.94	1.954	Not Applicable	1.0
Pyrene	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	SW846 3510, 8310	4	<0.1 µg/L	<0.1 µg/L	<0.1 µg/L	Not Applicable	Not Given
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.04 µg/L	Not Given	Not Applicable	0.04 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.060 µg/L	<0.060 µg/L	<0.060 µg/L	Not Applicable	0.060 µg/L

	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.075µg/L	<0.075µg/L	<0.075µg/L	<0.075µg/L	0.075µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	1.3 µg/L	Not Given	Not Applicable	0.075µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	0.74 µg/L	Not Given	Not Applicable	0.075µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	0.10 µg/L	Not Given	Not Applicable	0.075µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8270B, 3510B	6	<0.5 µg/L	<0.5 µg/L	<0.5 µg/L	Not Applicable	0.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8270B, 3510B	6	<0.5 µg/L	<0.5 µg/L	<0.5 µg/L	Not Applicable	0.5 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8270B, 3510B	6	<0.5 µg/L	<0.5 µg/L	<0.5 µg/L	Not Applicable	0.5 µg/L
Pyridine	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	6	Not Given	<60 µg/L	Not Given	Not Applicable	60 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<120 µg/L	<120 µg/L	<120 µg/L	Not Applicable	120 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	6	Not Given	<250 µg/L	Not Given	Not Applicable	250 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	6	Not Given	<250 µg/L	Not Given	Not Applicable	250 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	6	Not Given	<250 µg/L	Not Given	Not Applicable	250 µg/L
Selenium (Se)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.1	<0.1	<0.1	Not Applicable	0.1
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005

	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.025	<0.025	<0.025	Not Applicable	0.025
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.010	<0.010	<0.010	<0.010	0.010
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.005	Not Given	Not Applicable	0.005
Silver (Ag)	I-90, Big Timber, MT[a]	Pavement	Salvaged asphalt pavement	Cenex, Exxon, Conoco, Montana Refining	TCLP, SW846 1311	1	<0.5	<0.5	<0.5	Not Applicable	0.5
	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<0.040	Not Given	Not Applicable	0.040
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<0.040	<0.040	<0.040	Not Applicable	<0.040
	Heritage Research Group[d]	Route #4, Springfield, IL	Hot mix asphalt (HMA)	Route #4, Springfield, IL	TCLP, SW846-7080	5	<0.040	<0.040	<0.040	<0.040	<0.040
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.040	Not Given	Not Applicable	<0.040
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<0.040	Not Given	Not Applicable	<0.040
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<0.040	Not Given	Not Applicable	<0.040
Sodium (Na^+)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	<1.0		1.291	Not Applicable	1.0
Styrene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Sulfate	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Mehtod 429	6	5.17	7.20	11.36	Not Applicable	1.0
Tetrachloroethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1,1,2-Tetrachloroethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1,2,2-Tetrachloroethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

Tetrachloroethylene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
Toluene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Total Dissolved Solids (TDS)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, Method 209B	6	7	16	22	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, Method 209B	6	5	14	20	Not Applicable	Not Given
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, Method 209B	6	0	11	18	Not Applicable	Not Given
1,2,3-Trichlorobenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

1,2,4-Trichlorobenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,1,2-Tricholoethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Trichloroethene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Trichloroethylene	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5	Not Given	Not Applicable	5 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50	Not Given	Not Applicable	50

Trichlorofluoromethane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
2,4,5-Trichlorophenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 µg/L	Not Given	Not Applicable	30 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<250 µg/L	<250 µg/L	<250 µg/L	Not Applicable	250 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
2,4,6-Trichlorophenol	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	<30 µg/L	Not Given	Not Applicable	30 µg/L
	Heritage Research Group[c]	IAPA, IDOT	Recycled Aspahlt Pavement	RAP	TCLP, SW846-3010	6	<50 µg/L	<50 µg/L	<50 µg/L	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
	Heritage Research Group[e]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<50 µg/L	Not Given	Not Applicable	50 µg/L
1,2,3-Trichloropropane	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,2,4-Trimethylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
1,3,5-Trimethylbenzene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Vinyl Chloride	Heritage Research Group[b]	InDOT	Hot mix asphalt (HMA)	Aspalt Materials and Martin Marietta	TCLP, SW846-3010	1	Not Given	5 µg/L	Not Given	Not Applicable	5 µg/L
	Heritage Research Group[c]	Cold Mix Asphalt	Asphalt Emulsions (HFMS-2s)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
	Heritage Research Group[c]	Cold Mix Asphalt	Cutback Asphalt (MC-3000)	Laketon Refining, Laketon, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
	Heritage Research Group[c]	Cold Mix Asphalt	Gelled Asphalt (CM-300)	Asphalt Materials Inc, IN	TCLP, SW846-3010	1	Not Given	<100	Not Given	Not Applicable	100
m/p-Xylene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L

	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
o-Xylene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Total-Xylene	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, SW846-8260A	6	<1.0 µg/L	<1.0 µg/L	<1.0 µg/L	Not Applicable	1.0 µg/L
Zinc (Zn)	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	Deionized Water, 7950-51	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	TCLP, 7950-51	6	<0.5	<0.5	<0.5	Not Applicable	0.5
	University of Florida[f]	RAP samples from 6 locations in Florida	RAP	Miami, Tampa, Jacksonville, Lake City, Indian Town Road, I-10	SPLP, 7950-51	6	<0.5	<0.5	<0.5	Not Applicable	0.5

* In mg/L unless otherwise indicated

[a] Pribanic (1994)

[b] Kriech (1990)

[c] Kriech (1991)--arithmetic

[d] Kriech (1992a)--arithmetic

[e] Kriech (1992b)

f Brantley (1998)

APPENDIX B

Results of the Metal Analysis and semi-Volatile Organic Compound Analysis are shown in the following tables.

Aluminum

Table B-1. The mean and standard deviation for materials analyzed for aluminum

Material	No. Samples	Set 1		No. Samples	Set 2		No. Samples	Set 3		No. Samples	Set 4		Total		Range	
		Mean	SD		Mean	SD		Mean	SD		Mean	SD	Mean	SD		
Limestone	4	<2000	0.00	3	<2000	0.00	3	<2000	0.00	3	<2000	0.00	<2000	0		
Siliceous Gravel	2	<2000	0.00	2	<2000	0.00	4	<2000	0.00	2	<2000	0.00	<2000	0		
Sandstone	2	<2000	0.00	3	<2000	0.00							<2000	0		
Siliceous Sand	3	<2000	0.00										<2000	0		
Caliche	4	<2000	0.00	3	<2000	0.00							<2000	0		
LRA	4	<2000	0.00										<2000	0		
Waste Foundry Sand	3	2033	57.74	4	2000	0.00							2017	24	2000	2040
Fly Ash, Class F	4	7775	4405	3	7333	450.9	3	4700	200.0				6603	1663	4940	8265
Fly Ash, Class C	3	8000	819	2	13700	8627	3	28800	871.8	4	23250	4244	18438	9344	9094	27781
Cement Type I/II	3	<2000	0.00										<2000	0		
Cement Type I	3	<2000	0.00	4	<2000	0.00							<2000	0		
Cement Type II	4	<2000	0.00										<2000	0		
Lime, Type A	4	<2000	0.00	3	<2000	0.00	3	<2000	0.00				<2000	0		
Lime, Type B	3	<2000	0.00	4	<2000	0.00							<2000	0		
Lime, Type C	3	<2000	0.00	3	<2000	0.00	4	<2000	0.00				<2000	0		
Bottom Ash	3	4800	1411										4800	1411	3389	6211
Silica Fume	4	<2000	0.00										<2000	0		
RCP	4	<2000	0.00	3	<2000	0.00							<2000	0		
RAP	4	<2000	0.00	3	<2000	0.00							<2000	0		
Concrete	4	<2000	0.00										<2000	0		
Concrete-RCP	4	<2000	0.00										<2000	0		
Concrete-Fly Ash	4	<2000	0.00										<2000	0		

Note: Minimum Detection Limit = 2000 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Antimony

Table B-2. The mean and standard deviation for materials analyzed for antimony

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	5.22	0.44	3	<5.00	0.00	3	13.06	1.19	3	6.73	1.19	8.34	4.16	5.00	12.50
Siliceous Gravel	3	5.04	0.05	2	<5.00	0.00	4	5.03	0.06	4	11.76	4.43	7.27	3.88	5.00	11.16
Sandstone	3	<5.00	0.00	3	7.51	2.18							6.26	1.77	5.00	8.03
Siliceous Sand	3	13.03	5.41										13.03	5.41	7.62	18.44
Caliche	4	16.62	7.65	3	9.52	5.16							13.07	5.01	5.00	18.08
LRA	4	5.90	1.81										5.90	1.81	5.00	7.71
Waste Foundry Sand	3	8.96	4.02	4	<5.00	0.00							6.98	2.80	5.00	9.78
Fly Ash, Class F	4	23.97	5.02	2	6.66	0.64	3	30.75	3.60				20.46	12.43	8.03	32.88
Fly Ash, Class C	3	7.25	2.82	3	12.79	4.23	3	11.95	9.98	4	9.55	6.23	10.39	2.50	7.89	12.88
Cement Type I/II	3	<5.00	0.00										<5.00	0.00		
Cement Type I	3	7.33	3.38	4	7.06	3.55							7.19	0.19	7.00	7.38
Cement Type II	4	<5.00	0.00										<5.00	0.00		
Lime, Type A	4	<5.00	0.00	2	5.95	0.35	2	5.09	0.13				5.52	0.60	5.00	6.12
Lime, Type B	3	5.76	1.17	4	6.48	2.96							6.12	0.50	5.62	6.63
Lime, Type C	3	7.19	0.95	2	6.48	2.09	4	6.00	0.87				6.56	0.60	5.95	7.16
Bottom Ash	4	5.14	0.25										5.14	0.25	5.00	5.39
Silica Fume	4	<5.00	0.00										<5.00	0.00		
RCP	4	5.83	1.66	3	<5.00	0.00							5.83	0.59	5.00	6.42
RAP	4	5.16	0.31	3	6.32	1.59							5.74	0.82	5.00	6.56
Concrete	4	<5.00	0.00										<5.00	0.00		
Concrete-RCP	4	5.19	0.23										5.19	0.23	5.00	5.41
Concrete-Fly Ash	4	6.72	2.60										6.72	2.60	5.00	9.32

Note: Minimum Detection Limit = 5.00 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Arsenic

Table B-3. The mean and standard deviation for materials analyzed for arsenic

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	3	25.00	0.00	3	25.00	0.00	3	25.00	0.00	3	25.00	0.00	25.00	0.00		
Siliceous Gravel	3	25.00	0.00	3	25.00	0.00	4	25.00	0.00	4	25.00	0.00	25.00	0.00		
Sandstone	3	25.00	0.00	3	25.00	0.00							25.00	0.00		
Siliceous Sand	3	25.00	0.00										25.00	0.00		
Caliche	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
LRA	4	25.00	0.00										25.00	0.00		
Waste Foundry Sand	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Fly Ash, Class F	4	26.45	2.90	3	25.00	0.00	3	41.23	10.279				30.89	8.98	25.00	39.88
Fly Ash, Class C	3	25.00	0.00	3	25.00	0.00	3	25.00	0.00	4	25.00	0.00	25.00	0.00		
Cement Type I/II	3	25.00	0.00										25.00	0.00		
Cement Type I	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Cement Type II	4	25.00	0.00										25.00	0.00		
Lime, Type A	4	25.00	0.00	3	25.00	0.00	3	25.00	0.00				25.00	0.00		
Lime, Type B	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Lime, Type C	1	25.00	0.00	3	25.00	0.00	4	25.00	0.00				25.00	0.00		
Bottom Ash	3	25.00	0.00										25.00	0.00		
Silica Fume	4	31.20	3.33										31.20	3.33	27.87	34.53
RCP	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
RAP	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
Concrete	4	25.00	0.00										25.00	0.00		
Concrete-RCP	4	25.00	0.00										25.00	0.00		
Concrete-Fly Ash	4	25.00	0.00										25.00	0.00		

Note: Minimum Detection Limit = 25 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Barium

Table B-4. The mean and standard deviation for materials analyzed for barium

	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total			
Material	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD	Range	
Limestone	3	2000	0.00	3	2000	0.00	3	2000	0.00	4	2000	0.00	2000	0.00		
Siliceous Gravel	2	2000	0.00	3	2027	46.19	4	2000	0.00	3	2000	0.00	2007	13.33	2000	2020
Sandstone	2	2000	0.00	3	2000	0.00							2000	0.00		
Siliceous Sand	3	2000	0.00										2000	0.00		
Caliche	4	2000	0.00	3	2000	0.00							2000	0.00		
LRA	4	2000	0.00										2000	0.00		
Waste Foundry Sand	3	2000	0.00	4	2000	0.00							2000	0.00		
Fly Ash, Class F	4	2843	1685	3	2000	0.00	3	2000	0.00				2281	486	2000	2767
Fly Ash, Class C	3	2000	0.00	2	2000	0.00	3	2167	288.7	4	2503	601.7	2167	237	2000	2404
Cement Type I/II	3	3403	577.3										3403	577	2826	3981
Cement Type I	3	3310	285.8	4	3243	343.8							3276	48	3229	3324
Cement Type II	3	3987	790.0										3987	790	3197	4777
Lime, Type A	4	6003	540.6	3	6200	528.5	3	6690	242.7				6298	354	5944	6651
Lime, Type B	3	4053	262.7	4	7428	505.1							5740	2386	3355	8126
Lime, Type C	3	6580	244.4	3	2903	244.4	4	4495	457.0				4659	1844	2816	6503
Bottom Ash	3	2000	0.00										2000	0.00		
Silica Fume	4	2000	0.00										2000	0.00		
RCP	4	2000	0.00	3	2000	0.00							2000	0.00		
RAP	4	2000	0.00	3	2013	23.09							2007	9.43	2000	2016
Concrete	4	2335	269.63										2335	270	2065	2605
Concrete-RCP	4	2540	364.0										2540	364	2176	2904
Concrete-Fly Ash	4	3365	202.9										3365	203	3162	3568

Note: Minimum Detection Limit = 2000 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Beryllium

Table B-5. The mean and standard deviation for materials analyzed for beryllium

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	1.00	0.00	3	1.00	0.00	3	1.00	0.00	3	1.00	0.00	1.00	0.00		
Siliceous Gravel	3	1.00	0.00	3	1.00	0.00	4	1.00	0.00	4	1.00	0.00	1.00	0.00		
Sandstone	3	1.00	0.00	2	1.00	0.00							1.00	0.00		
Siliceous Sand	3	1.00	0.00										1.00	0.00		
Caliche	4	1.06	0.13	3	1.00	0.00							1.03	0.04	1.00	1.08
LRA	4	1.00	0.00										1.00	0.00		
Waste Foundry Sand	3	1.28	0.24	4	1.00	0.00							1.14	0.20	1.00	1.33
Fly Ash, Class F	4	1.33	0.65	3	1.00	0.00	3	1.00	0.00				1.11	0.19	1.00	1.30
Fly Ash, Class C	3	1.00	0.00	2	1.00	0.00	3	1.00	0.00	4	1.00	0.00	1.00	0.00		
Cement Type I/II	3	1.00	0.00										1.00	0.00		
Cement Type I	3	1.00	0.00	4	1.00	0.00							1.00	0.00		
Cement Type II	4	1.00	0.00										1.00	0.00		
Lime, Type A	4	1.00	0.00	3	1.00	0.00	3	1.00	0.00				1.00	0.00		
Lime, Type B	3	1.00	0.00	4	1.00	0.00							1.00	0.00		
Lime, Type C	3	1.00	0.00	3	1.00	0.00	4	1.00	0.00				1.00	0.00		
Bottom Ash	3	1.00	0.00										1.00	0.00		
Silica Fume	4	1.00	0.00										1.00	0.00		
RCP	4	1.00	0.00	3	1.00	0.00							1.00	0.00		
RAP	4	1.00	0.00	3	1.00	0.00							1.00	0.00		
Concrete	4	1.07	0.15										1.07	0.15	1.00	1.22
Concrete-RCP	4	1.00	0.00										1.00	0.00		
Concrete-Fly Ash	4	1.00	0.00										1.00	0.00		

Note: Minimum Detection Limit = 1.00 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Cadmium

Table B-6. The mean and standard deviation for materials analyzed for cadmium

	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total			
Material	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD	Range	
Limestone	4	1.86	1.36	3	1.54	0.80	3	1.00	0.00	3	2.62	2.36	1.75	0.68	1.08	2.43
Siliceous Gravel	3	1.14	0.24	3	1.00	0.00	4	1.08	0.11	4	1.00	0.00	1.06	0.07	1.00	1.12
Sandstone	3	1.28	0.07	2	1.00	0.00							1.14	0.20	1.00	1.34
Siliceous Sand	3	1.00	0.00										1.00	0.00		
Caliche	4	1.00	0.00	3	1.00	0.00							1.00	0.00		
LRA	4	1.11	0.22										1.11	0.22	1.00	1.33
Waste Foundry Sand	3	1.00	0.00	4	1.92	1.85							1.46	0.65	2.11	2.11
Fly Ash, Class F	3	1.00	0.00	3	1.39	0.55	3	1.81	0.78				1.40	0.41	1.00	1.80
Fly Ash, Class C	3	1.77	0.84	3	1.54	0.56	3	1.00	0.00	4	1.00	0.00	1.33	0.39	1.00	1.72
Cement Type I/II	3	1.00	0.00										1.00	0.00		
Cement Type I	3	2.48	2.28	4	1.56	0.63							2.02	0.65	1.37	2.67
Cement Type II	4	1.47	0.56										1.47	0.56	1.00	2.03
Lime, Type A	4	2.03	0.28	3	2.38	2.26	3	2.46	1.70				2.29	0.23	2.06	2.52
Lime, Type B	3	1.61	1.06	4	2.23	0.57							1.92	0.43	1.48	2.35
Lime, Type C	3	1.51	0.00	3	1.00	0.00	4	1.00	0.00				1.17	0.36	1.00	1.53
Bottom Ash	3	1.00	0.00										1.00	0.00		
Silica Fume	4	1.00	0.00										1.00	0.00		
RCP	4	1.62	0.64	3	1.82	1.06							1.72	0.14	1.58	1.86
RAP	4	1.16	0.33	3	1.85	11.54							1.51	0.49	1.02	2.00
Concrete	4	1.00	0.00										1.00	0.00		
Concrete-RCP	4	1.00	0.00										1.00	0.00		
Concrete-Fly Ash	4	1.09	0.19										1.09	0.19	1.00	1.28

Note: Minimum Detection Limit = 1 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Chromium

Table B-7. The mean and standard deviation for materials analyzed for chromium

Material	No. Samples	Set 1		No. Samples	Set 2		No. Samples	Set 3		No. Samples	Set 4		Total		Range	
		Mean	SD		Mean	SD		Mean	SD		Mean	SD	Mean	SD		
Limestone	4	19.04	28.08	3	5.00	0.00	3	5.00	0.00	3	5.00	0.00	8.51	7.02	5.00	15.53
Siliceous Gravel	3	8.24	5.62	3	7.85	4.94	4	10.29	10.58	3	5.00	0.00	7.85	2.18	5.67	10.02
Sandstone	3	7.39	4.14	2	14.69	13.7							11.04	5.16	5.88	16.20
Siliceous Sand	3	5.65	1.13										5.65	1.13	5.00	6.78
Caliche	4	5.00	0.00	3	5.00	0.00							5.00	0.00		
LRA	4	29.25	46.65										29.25	46.65	5.00	75.90
Waste Foundry Sand	2	9.31	6.09	4	14.4	10.0							11.87	3.62	8.24	15.49
Fly Ash, Class F	4	196.3	38.95	3	297.2	21.9	3	95.07	9.17				196.2	101.07	95.14	297.27
Fly Ash, Class C	3	17.10	0.78	3	70.2	57.6	2	210.8	27.86	3	211.8	92.21	127.5	99.21	28.26	226.69
Cement Type I/II	3	22.80	0.72										22.80	0.72	22.08	23.52
Cement Type I	3	22.47	6.71	4	31.83	14.47							27.15	6.62	20.53	33.76
Cement Type II	4	160.9	69.05										160.85	69.05	91.80	229.90
Lime, Type A	4	39.37	10.09	3	12.50	0.64	3	21.09	14.01				24.32	13.72	10.60	38.04
Lime, Type B	3	40.41	18.34	4	8.29	2.33							24.35	22.71	5.00	47.07
Lime, Type C	3	26.69	5.74	3	21.52	5.74	4	19.46	2.72				22.56	3.72	18.83	26.28
Bottom Ash	4	10.60	4.34										10.60	4.34	6.26	14.94
Silica fume	4	10.57	1.65										10.57	1.65	8.92	12.22
RCP	4	14.77	3.58	3	18.4	3.49							16.60	2.59	14.01	19.20
RAP	4	5.00	0.00	3	5.99	1.71							5.50	0.70	5.00	6.20
Concrete	4	45.15	8.00										45.15	8.00	37.15	53.15
Concrete-RCP	4	40.39	3.36										40.39	3.36	37.02	43.75
Concrete-Fly Ash	4	39.16	4.04										39.16	4.04	35.11	43.20

Note: Minimum Detection Limit = 5 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Cobalt

Table B-8. The mean and standard deviation for materials analyzed for cobalt

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00	3	100.00	0.00	100.00	0.00		
Siliceous Gravel	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00	2	100.00	0.00	100.00	0.00		
Sandstone	3	100.00	0.00	2	100.00	0.00							100.00	0.00		
Siliceous Sand	3	100.00	0.00										100.00	0.00		
Caliche	4	100.00	0.00	3	100.00	0.00							100.00	0.00		
LRA	4	100.00	0.00										100.00	0.00		
Waste Foundry Sand	3	100.00	0.00	4	100.00	0.00							100.00	0.00		
Fly Ash, Class F	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00		
Fly Ash, Class C	3	100.00	0.00	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00	100.00	0.00		
Cement Type I/II	3	100.00	0.00										100.00	0.00		
Cement Type I	3	100.00	0.00	4	100.00	0.00							100.00	0.00		
Cement Type II	4	100.00	0.00										100.00	0.00		
Lime, Type A	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00		
Lime, Type B	3	100.00	0.00	4	100.00	0.00							100.00	0.00		
Lime, Type C	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00				100.00	0.00		
Bottom Ash	4	100.00	0.00										100.00	0.00		
Silica Fume	4	100.00	0.00										100.00	0.00		
RCP	4	100.00	0.00	3	100.00	0.00							100.00	0.00		
RAP	4	100.00	0.00	3	100.00	0.00							100.00	0.00		
Concrete	0	NA	NA										NA	NA		
Concrete-RCP	0	NA	NA										NA	NA		
Concrete-Fly Ash	0	NA	NA										NA	NA		

Note: Minimum Detection Limit = 100 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Copper

Table B-9. The mean and standard deviation for materials analyzed for copper

Material	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total		Range
	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD	
Limestone	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00	3	100.00	0.00	100.00	0.00	
Siliceous Gravel	3	100.00	0.00	2	100.00	0.00	4	100.00	0.00	4	100.00	0.00	100.00	0.00	
Sandstone	3	100.00	0.00	3	100.00	0.00							100.00	0.00	
Siliceous Sand	3	100.00	0.00										100.00	0.00	
Caliche	4	100.00	0.00	3	100.00	0.00							100.00	0.00	
LRA	4	100.00	0.00										100.00	0.00	
Waste Foundry Sand	3	100.00	0.00	4	100.00	0.00							100.00	0.00	
Fly Ash, Class F	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00	
Fly Ash, Class C	3	100.00	0.00	2	100.00	0.00	3	100.00	0.00	4	100.00	0.00	100.00	0.00	
Cement Type I/II	3	100.00	0.00										100.00	0.00	
Cement Type I	3	100.00	0.00	4	100.00	0.00							100.00	0.00	
Cement Type II	3	100.00	0.00										100.00	0.00	
Lime, Type A	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00	
Lime, Type B	3	100.00	0.00	4	100.00	0.00							100.00	0.00	
Lime, Type C	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00				100.00	0.00	
Bottom Ash	4	100.00	0.00										100.00	0.00	
Silica Fume	4	100.00	0.00										100.00	0.00	
RCP	4	100.00	0.00	3	100.00	0.00							100.00	0.00	
RAP	4	100.00	0.00	3	100.00	0.00							100.00	0.00	
Concrete	0	NA	NA										NA	NA	
Concrete-RCP	0	NA	NA										NA	NA	
Concrete-Fly Ash	0	NA	NA										NA	NA	

Note: Minimum Detection Limit = 100 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Lead

Table B-10. The mean and standard deviation for materials analyzed for lead

Material	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total		Range	
	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD		
Limestone	4	19.09	6.87	3	19.09	11.50	3	5.00	0.00	3	20.30	3.20	15.87	7.27	8.60	23.14
Siliceous Gravel	3	22.39	13.11	3	9.43	3.03	4	13.19	9.95	4	10.75	6.69	13.94	5.85	8.09	19.78
Sandstone	3	15.97	6.59	2	9.09	1.78							12.53	4.86	7.67	17.39
Siliceous Sand	3	8.72	2.97										8.72	2.97	5.75	11.69
Caliche	4	14.89	4.56	3	5.00	0.00							9.95	6.99	5.00	16.94
LRA	4	12.87	4.11										12.87	4.11	8.75	16.98
Waste Foundry Sand	2	21.40	2.36	4	9.06	5.19							15.23	8.72	23.95	23.95
Fly Ash, Class F	4	11.44	6.59	3	13.45	11.94	3	21.95	3.55				15.61	5.58	10.03	21.19
Fly Ash, Class C	3	19.18	1.76	3	36.19	15.85	3	5.72	1.25	4	8.38	3.90	17.37	13.83	5.00	31.20
Cement Type I/II	3	24.93	8.36										24.93	8.36	16.57	33.30
Cement Type I	3	19.01	13.19	4	12.64	3.94							15.82	4.50	11.32	20.33
Cement Type II	4	31.45	16.59										31.45	16.59	14.86	48.03
Lime, Type A	4	68.55	39.23	3	70.64	13.50	3	46.15	13.71				61.78	13.58	48.20	75.36
Lime, Type B	3	31.11	8.37	4	49.09	20.02							40.10	12.72	27.38	52.81
Lime, Type C	3	44.63	27.77	3	51.37	27.77	4	22.39	11.17				39.46	15.17	24.29	54.63
Bottom Ash	4	5.88	1.18										5.88	1.18	5.00	7.06
Silica fume	4	13.66	8.89										13.66	8.89	5.00	22.55
RCP	4	14.31	8.26	3	11.49	5.63							12.90	1.99	10.91	14.89
RAP	4	20.43	11.63	3	20.40	11.10							20.42	0.02	20.00	20.44
Concrete	4	72.07	92.58										72.07	92.58	5.00	164.65
Concrete-RCP	4	16.60	7.03										16.60	7.03	9.57	23.63
Concrete-Fly Ash	4	34.07	9.71										34.07	9.71	24.36	43.78

Note: Minimum Detection Limit = 5 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Manganese

Table B-11. The mean and standard deviation for materials analyzed for manganese

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00	3	100.00	0.00	100.00	0.00		
Siliceous Gravel	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00	4	100.00	0.00	100.00	0.00		
Sandstone	3	100.00	0.00	3	100.00	0.00							100.00	0.00		
Siliceous Sand	3	100.00	0.00										100.00	0.00		
Caliche	4	100.00	0.00	3	100.00	0.00							100.00	0.00		
LRA	4	100.00	0.00										100.00	0.00		
Waste Foundry Sand	3	140.00	69.28	4	100.00	0.00							120.00	28.28	100.00	148.28
Fly Ash, Class F	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00		
Fly Ash, Class C	3	100.00	0.00	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00	100.00	0.00		
Cement Type I/II	3	100.00	0.00										100.00	0.00		
Cement Type I	3	100.00	0.00	4	100.00	0.00							100.00	0.00		
Cement Type II	3	186.67	150.11										186.67	150.11	100.00	336.78
Lime, Type A	4	100.00	0.00	3	100.00	0.00	3	100.00	0.00				100.00	0.00		
Lime, Type B	3	100.00	0.00	4	100.00	0.00							100.00	0.00		
Lime, Type C	3	100.00	0.00	3	100.00	0.00	4	100.00	0.00				100.00	0.00		
Bottom Ash	4	100.00	0.00										100.00	0.00		
Silica Fume	4	100.00	0.00										100.00	0.00		
RCP	4	100.00	0.00	3	100.00	0.00							100.00	0.00		
RAP	4	100.00	0.00	3	113.33	15.28							106.67	9.43	100.00	116.09
Concrete	4	100.00	0.00										100.00	0.00		
Concrete-RCP	4	100.00	0.00										100.00	0.00		
Concrete-Fly Ash	4	100.00	0.00										100.00	0.00		

Note: Minimum Detection Limit = 100 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Mercury

Table B-12. The mean and standard deviation for materials analyzed for mercury

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	1	2.00	0.00	1	9.20	0.00	1	2.00	0.00	1	25.79	0.00	9.75	11.2	2.00	21.0
Siliceous Gravel	1	2.00	0.00	1	2.00	0.00	1	29.8	0.00	1	26.24	0.00	15.0	15.1	2.00	30.1
Sandstone	1	2.00	0.00	1	21.6	0.00							11.8	13.9	2.00	25.7
Siliceous Sand	0	0.00	0.00										0.00	0.00		
Caliche	1	2.00	0.00	1	2.00	0.00							2.00	0.00		
LRA	1	19.8	0.00										19.8	0.00	19.8	19.8
Waste Foundry Sand	1	23.4	0.00	1	2.00	0.00							12.7	15.1	27.8	27.8
Fly Ash, Class F	1	2.00	0.00	1	2.00	0.00	1	2.00	0.00				2.00	0.00		
Fly Ash, Class C	1	2.00	0.00	1	2.41	0.00	1	2.00	0.00	1	3.86	0.00	2.57	0.88	2.00	3.45
Cement Type I/II	1	2.00	0.00										2.00	0.00		
Cement Type I	1	2.00	0.00	1	2.00	0.00							2.00	0.00		
Cement Type II	1	2.00	0.00										2.00	0.00		
Lime, Type A	3	2.00	0.00	1	4.17	0.00	3	2.00	0.0				2.72	1.25	2.00	3.98
Lime, Type B	3	2.00	0.00	4	2.00	0.00							2.00	0.00		
Lime, Type C	3	2.00	0.00	3	2.00	0.00	3	2.16	0.27				2.05	0.09	2.00	2.14
Bottom Ash	3	2.00	0.00										2.00	0.00		
Silica fume	2	2.00	0.00										2.00	0.00		
RCP	2	8.57	9.29	2	2.00	0.00							5.29	4.65	2.00	9.93
RAP	3	2.00	0.00	3	2.00	10.7							2.00	0.00		
Concrete	4	2.00	0.00										2.00	0.00		
Concrete-RCP	4	2.00	0.00										2.00	0.00		
Concrete-Fly Ash	4	2.00	0.00										2.00	0.00		

Note: Minimum Detection Limit = 2 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Molybdenum

Table B-13. The mean and standard deviation for materials analyzed for molybdenum

Material	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total		Range	
	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD		
Limestone	4	12.48	4.95	3	10.00	0.00	3	10.00	0.00	3	10.00	0.00	10.62	1.24	10.00	11.86
Siliceous Gravel	3	10.00	0.00	3	10.00	0.00	4	10.00	0.00	4	10.00	0.00	10.00	0.00		
Sandstone	3	10.00	0.00	2	10.00	0.00							10.00	0.00		
Siliceous Sand	3	10.00	0.00										10.00	0.00		
Caliche	4	19.53	9.53	3	10.00	0.00							14.76	6.74	10.00	21.50
LRA	4	12.38	4.75										12.38	4.75	10.00	17.13
Waste Foundry Sand	3	107.7	166.6	4	21.25	14.22							64.46	61.11	10.00	125.6
Fly Ash, Class F	4	48.55	38.06	3	204.00	9.54	3	622.0	31.11				291.52	296.57	10.00	588.1
Fly Ash, Class C	3	73.80	38.92	3	322.8	375.0	3	149.4	71.82	4	186.8	18.96	183.2	104.3	78.94	287.5
Cement Type I/II	3	10.00	0.00										10.00	0.00		
Cement Type I	3	10.00	0.00	4	10.00	0.00							10.00	0.00		
Cement Type II	4	13.20	4.53										13.20	4.53	10.00	17.73
Lime, Type A	4	10.00	0.00	3	10.00	0.00	3	10.00	0.00				10.00	0.00		
Lime, Type B	3	10.00	0.00	4	16.40	7.42							13.20	5.25	10.00	18.45
Lime, Type C	3	10.40	0.69	3	10.63	1.10	4	10.00	0.00				10.34	0.55	10.00	10.90
Bottom Ash	4	10.40	0.69										10.40	0.69	10.00	11.09
Silica Fume	4	34.13	6.19										34.13	6.19	27.93	40.32
RCP	4	10.00	0.00	3	10.00	0.00							10.00	0.00		
RAP	4	10.00	0.00	3	10.00	0.00							10.00	0.00		
Concrete	4	10.00	0.00										10.00	0.00		
Concrete-RCP	4	10.00	0.00										10.00	0.00		
Concrete-Fly Ash	4	10.00	0.00										10.00	0.00		

Note: Minimum Detection Limit = 10 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Nickel

Table B-14. The mean and standard deviation for materials analyzed for nickel

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	53.38	6.75	3	59.77	9.25	3	50.00	16.77	3	68.63	16.77	57.94	8.20	50.00	66.14
Siliceous Gravel	3	50.00	0.00	3	52.85	4.03	4	60.35	43.47	3	114.9	91.78	69.52	30.56	50.00	100.1
Sandstone	3	56.10	8.63	2	50.00	0.00							53.05	4.31	50.00	57.36
Siliceous Sand	3	50.00	0.00										50.00	0.00		
Caliche	4	50.00	0.00	3	50.00	0.00							50.00	0.00		
LRA	4	86.10	51.87										86.10	51.87	34.23	138.0
Waste Foundry Sand	3	716.0	1154	4	51.10	1.28							383.55	470.16	50.00	853.7
Fly Ash, Class F	4	51.00	2.00	3	61.20	19.40	3	123.9	58.22				78.70	39.48	50.00	118.2
Fly Ash, Class C	3	67.00	29.44	3	82.05	38.40	3	99.87	76.88	4	64.80	29.60	78.43	16.22	62.21	94.65
Cement Type I/II	3	50.00	0.00										50.00	0.00		
Cement Type I	3	84.87	26.48	4	78.88	35.53							81.87	4.24	77.63	86.11
Cement Type II	4	70.73	33.75										70.73	33.75	50.00	104.5
Lime, Type A	4	50.00	0.00	3	50.00	0.00	3	50.00	0.00				50.00	0.00		
Lime, Type B	3	55.77	6.37	4	65.85	27.11							60.81	7.13	53.68	67.94
Lime, Type C	3	50.00	0.00	3	57.10	12.30	4	72.40	26.29				59.83	11.45	50.00	71.28
Bottom Ash	3	50.00	0.00										50.00	0.00		
Silica Fume	4	50.00	0.00										50.00	0.00		
RCP	4	79.75	46.02	2	50.00	0.00							64.88	21.04	50.00	85.91
RAP	4	50.00	0.00	3	50.00	0.00							50.00	0.00		
Concrete	4	50.00	0.00										50.00	0.00		
Concrete-RCP	4	67.85	14.81										67.85	14.81	53.04	82.66
Concrete-Fly Ash	4	50.00	0.00										50.00	0.00		

Note: Minimum Detection Limit = 50 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Selenium

Table B-15. The mean and standard deviation for materials analyzed for selenium

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	3	25.00	0.00	3	25.00	0.00	3	25.00	0.00	3	25.00	0.00	25.00	0.00		
Siliceous Gravel	3	25.00	0.00	3	25.00	0.00	4	25.00	0.00	4	25.00	0.00	25.00	0.00		
Sandstone	3	25.00	0.00	3	25.00	0.00							25.00	0.00		
Siliceous Sand	3	25.00	0.00										25.00	0.00		
Caliche	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
LRA	4	25.00	0.00										25.00	0.00		
Waste Foundry Sand	3	366.7	591.8	4	25.00	0.00							195.8	241.6	25.00	437.4
Fly Ash, Class F	4	263.6	433.7	3	57.80	2.80	3	25.00	0.00				115.5	129.3	25.00	244.8
Fly Ash, Class C	1	25.00	0.00	3	25.00	0.00	3	74.17	5.74	4	29.20	8.40	38.34	23.97	25.00	62.31
Cement Type I/II	3	25.00	0.00										25.00	0.00		
Cement Type I	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Cement Type II	4	25.00	0.00										25.00	0.00		
Lime, Type A	4	25.00	0.00	3	25.00	0.00	3	25.00	0.00				25.00	0.00		
Lime, Type B	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Lime, Type C	3	25.00	0.00	3	25.00	0.00	4	25.00	0.00				25.00	0.00		
Bottom Ash	4	25.00	0.00										25.00	0.00		
Silica fume	4	214.3	206.1										214.3	206.1	25.00	420.4
RCP	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
RAP	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
Concrete	4	25.00	0.00										25.00	0.00		
Concrete-RCP	4	25.00	0.00										25.00	0.00		
Concrete-Fly Ash	4	25.00	0.00										25.00	0.00		

Note: Minimum Detection Limit = 25 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Silver

Table B-16. The mean and standard deviation for materials analyzed for silver

Material	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total		Range	
	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Samples	Mean	SD	Mean	SD		
Limestone	4	100.00	0.00	3	100	0	3	100	0.00	3	100	0	100	0		
Siliceous Gravel	3	100.00	0.00	3	100	0	4	100	0.00	2	100	0	100	0		
Sandstone	3	100.00	0.00	2	100	0							100	0		
Siliceous Sand	3	100.00	0.00										100	0		
Caliche	4	100.00	0.00	3	100	0							100	0		
LRA	4	100.00	0.00										100	0		
Waste Foundry Sand	3	100.00	0.00	4	100	0							100	0		
Fly Ash, Class F	4	100.00	0.00	3	100	0	3	100	0.00				100	0		
Fly Ash, Class C	3	100.00	0.00	3	100	0	3	100	0.00	4	100	0.0	100	0		
Cement Type I/II	3	100.00	0.00										100	0		
Cement Type I	3	100.00	0.00	4	100	0							100	0		
Cement Type II	2	100.00	0.00										100	0		
Lime, Type A	4	100.00	0.00	3	100	0	3	100	0.00				100	0		
Lime, Type B	3	100.00	0.00	4	100	0							100	0		
Lime, Type C	3	100.00	0.00	2	100	0	4	100	0.00				100	0		
Bottom Ash	4	100.00	0.00										100	0		
Silica fume	4	100.00	0.00										100	0		
RCP	4	100.00	0.00	3	100	0							100	0		
RAP	4	100.00	0.00	3	100	34							100	0		
Concrete		NA	NA										NA	NA		
Concrete-RCP		NA	NA										NA	NA		
Concrete-Fly Ash		NA	NA										NA	NA		

Note: Minimum Detection Limit = 100 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Thallium

Table B-17. The mean and standard deviation for materials analyzed for thallium

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	2.00	0.00	3	2.00	0.00	3	2.00	0.00	3	2.00	0.00	2.00	0.00		
Siliceous Gravel	3	2.00	0.00	3	2.00	0.00	4	2.00	0.00	3	2.00	0.00	2.00	0.00		
Sandstone	3	2.00	0.00	2	2.00	0.00							2.00	0.00		
Siliceous Sand	3	2.00	0.00										2.00	0.00		
Caliche	4	2.00	0.00	3	2.00	0.00							2.00	0.00		
LRA	4	2.00	0.00										2.00	0.00		
Waste Foundry Sand	3	2.00	0.00	4	2.00	0.00							2.00	0.00		
Fly Ash, Class F	4	2.00	0.00	3	2.00	0.00	3	2.00	0.00				2.00	0.00		
Fly Ash, Class C	3	2.00	0.00	3	2.00	0.00	3	2.00	0.00	4	2.00	0.00	2.00	0.00		
Cement Type I/II	3	2.00	0.00										2.00	0.00		
Cement Type I	3	2.00	0.00	4	2.00	0.00							2.00	0.00		
Cement Type II	4	2.00	0.00										2.00	0.00		
Lime, Type A	4	2.00	0.00	3	2.00	0.00	3	2.00	0.00				2.00	0.00		
Lime, Type B	3	2.00	0.00	4	2.00	0.00							2.00	0.00		
Lime, Type C	3	2.00	0.00	3	2.00	0.00	4	2.00	0.00				2.00	0.00		
Bottom Ash	3	2.00	0.00										2.00	0.00		
Silica Fume	4	2.00	0.00										2.00	0.00		
RCP	3	2.00	0.00	3	2.00	0.00							2.00	0.00		
RAP	3	2.00	0.00	3	2.00	0.00							2.00	0.00		
Concrete	0	NA	NA										NA	NA		
Concrete-RCP	0	NA	NA										NA	NA		
Concrete-Fly Ash	0	NA	NA										NA	NA		

Note: Minimum Detection Limit = 2 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Vanadium

Table B-18. The mean and standard deviation for materials analyzed for vanadium

Material	No. Samples	Set 1 Mean	Set 1 SD	No. Samples	Set 2 Mean	Set 2 SD	No. Samples	Set 3 Mean	Set 3 SD	No. Samples	Set 4 Mean	Set 4 SD	Total Mean	Total SD	Range	
Limestone	4	25.00	0.00	3	50.01	3.69	3	25.00	0.00	3	25.00	0.00	31.25	12.51	25.00	43.76
Siliceous Gravel	3	25.00	0.00	3	25.00	0.00	4	49.61	42.94	4	25.00	0.00	31.15	12.30	25.00	43.46
Sandstone	3	25.00	0.00	2	25.00	0.00							25.00	0.00		
Siliceous Sand	3	25.00	0.00										25.00	0.00		
Caliche	4	54.38	9.05	3	25.00	0.00							39.69	20.77	25.00	60.46
LRA	4	73.60	64.05										73.60	64.05	25.00	137.6
Waste Foundry Sand	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Fly Ash, Class F	4	448.2	252.2	3	206.5	11.95	3	210.9	31.50				288.6	138.3	150.3	426.9
Fly Ash, Class C	3	48.97	10.16	3	59.80	7.78	3	253.6	260.2	4	125.0	29.79	121.8	94.04	27.80	215.9
Cement Type I/II	3	25.00	0.00										25.00	0.00		
Cement Type I	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Cement Type II	4	25.00	0.00										25.00	0.00		
Lime, Type A	4	25.00	0.00	3	25.00	0.00	3	25.00	0.00				25.00	0.00		
Lime, Type B	3	25.00	0.00	4	25.00	0.00							25.00	0.00		
Lime, Type C	3	25.00	0.00	3	25.00	0.00	4	25.00	0.00				25.00	0.00		
Bottom Ash	3	57.43	10.74										57.43	10.74	46.69	68.18
Silica Fume	4	25.75	1.50										25.75	1.50	25.00	27.25
RCP	4	25.00	0.00	3	25.00	0.00							25.00	0.00		
RAP	4	25.00	0.00	3	25.33	0.58							25.17	0.24	25.00	25.40
Concrete	4	25.00	0.00										25.00	0.00		
Concrete-RCP	4	25.00	0.00										25.00	0.00		
Concrete-Fly Ash	4	25.00	0.00										25.00	0.00		

Note: Minimum Detection Limit = 25 µg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

Zinc

Table B-19. The mean and standard deviation for materials analyzed for zinc

Material	No. Samples	Set 1		No. Samples	Set 2		No. Samples	Set 3		No. Samples	Set 4		Total		Range	
		Mean	SD		Mean	SD		Mean	SD		Mean	SD	Mean	SD		
Limestone	4	463	416	3	100	0.00	3	100	23.09	3	113	23	194	179	100	373
Siliceous Gravel	3	390	141	2	365	0.28	4	553	905	2	130	42	359	174	185	533
Sandstone	3	100	0.00	3	880	944							490	552	100	1042
Siliceous Sand	3	100	0.00										100	0		
Caliche	4	153	75	3	100	0.00							126	37	100	163
LRA	4	100	0.00										100	0		
Waste Foundry Sand	3	117	15	4	355	407							236	169	100	404
Fly Ash, Class F	4	265	123	3	110	17.32	3	413	491				263	152	111	414
Fly Ash, Class C	3	613	889	2	1080	1216	3	263	107	4	108	15	516	431	100	947
Cement Type I/II	3	557	791										557	791	100	1348
Cement Type I	3	1977	630	4	873	678							1425	781	644	2205
Cement Type II	3	140	69.28										140	69	100	209
Lime, Type A	4	1478	1574	3	180	79.37	3	113	12				590	769	100	1359
Lime, Type B	3	3410	3290	4	125	30.00							1768	2323	100	4090
Lime, Type C	3	167	57.74	3	2670	3147	4	590	895				1142	1340	100	2482
Bottom Ash	3	100	0.00										100	0		
Silica Fume	4	593	894										593	894	100	1487
RCP	4	100	0.00	3	2470	507							1285	1676	100	2961
RAP	3	290	255	3	977	888							633	486	148	1119
Concrete	4	583	965										583	965	100	1548
Concrete-RCP	4	220	165										220	165	100	385
Concrete-Fly Ash	4	358	451										358	451	100	808

Note: Minimum Detection Limit = 100 μg/L

Note: For samples having values above and below the detection limit, the detection limit L was used for calculating the averages and standard deviations.

Note: The range is the mean +/- the standard deviation, unless the lower limit was less than the detection limit, which the detection limit was used.

pH

Table B-20. The mean and standard deviation for materials analyzed for pH

	No.	Set 1		No.	Set 2		No.	Set 3		No.	Set 4		Total			
Material	**Samples**	**Mean**	**SD**	**Samples**	**Mean**	**SD**	**Samples**	**Mean**	**SD**	**Samples**	**Mean**	**SD**	**Mean**	**SD**	**Range**	
Limestone	4	9.17	0.19	3	9.30	0.03	3	9.43	0.08	3	9.45	0.08	9.34	0.13	9.21	9.47
Siliceous Gravel	3	4.34	1.29	3	8.43	0.08	4	3.63	2.37	4	7.84	2.04	6.06	2.43	3.63	8.49
Sandstone	3	4.40	1.08	3	8.65	0.60							6.52	3.01	3.51	9.53
Siliceous Sand	3	5.60	0.20										5.60	0.20	5.40	5.80
Caliche	4	9.54	0.10	3	9.21	0.17							9.37	0.24	9.14	9.61
LRA	4	9.31	0.20										9.31	0.20	9.10	9.51
Waste Foundry Sand	3	9.69	0.36	4	9.43	0.13							9.56	0.19	9.37	9.74
Fly Ash, Class F	4	10.91	0.08	3	11.06	0.30	3	11.27	0.05				11.08	0.18	10.90	11.26
Fly Ash, Class C	3	11.20	0.07	3	11.10	0.29	3	10.93	0.05	4	10.63	0.04	10.96	0.25	10.72	11.21
Cement Type I/II	3	12.21	0.00										12.21	0.00	12.21	12.21
Cement Type I	3	12.12	0.11	4	11.96	0.06							12.04	0.11	11.92	12.15
Cement Type II	4	11.99	0.12										11.99	0.12	11.87	12.11
Lime, Type A	4	NA	BA	3	NA	NA	3	NA	NA				NA	NA	NA	NA
Lime, Type B	3	12.19	0.13	2	12.41	0.01							12.30	0.15	12.15	12.45
Lime, Type C	3	12.42	0.14	3	12.21	0.30	4	12.22	0.06				12.28	0.12	12.17	12.40
Bottom Ash	4	10.89	0.08										10.89	0.08	10.81	10.96
Silica Fume	4	9.83	0.01										9.83	0.01	9.81	9.84
RCP	4	10.65	0.06	3	11.24	0.03							10.94	0.42	10.52	11.36
RAP	4	8.86	0.77	3	9.37	0.14							9.12	0.36	8.76	9.48
Concrete	4	12.17	0.07										12.17	0.07	12.09	12.24
Concrete-RCP	4	12.15	0.10										12.15	0.10	12.05	12.25
Concrete-Fly Ash	4	11.13	0.05										11.13	0.05	11.07	11.18

APPENDIX C

A sample log is shown in the following table.

Appendix C Sample Log (Note: Supplier Names have been removed)

Date Rec	Code	Item Description	Sent	Size	Qnt.	Int.
Bituminous Binders						
1/19/2000	0101 (A-E)	MC-30 (Tank 29)	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0102 (A-E)	MC-30	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0103 (A-E)	AC-3 (Tank M6/02)	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0104 (A-E)	AC-5 (Tank M6/02)	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0105 (A-E)	PG 64-22 (Tank 114)	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0106 (A-E)	PG64-22	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0107 (A-E)	AC-3	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0108 (A-E)	MC-30	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0109 (A-E)	AC-5	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0110 (A-E)	CRS-2	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0111 (A-E)	PG 64-22	UPS/TxDOT	1 gal.	5	AM
1/19/2000	0112	Patch Mix	UPS/TxDOT	5 gal.	1	AM
2/3/2000	0118	MC-30	UPS/TxDOT	1 gal.	1	AM
2/4/2000	0119	PG 64-22	UPS/TxDOT	5 gal.	1	AM
2/10/2000	0121 (A-E)	AC-15-5TR	UPS/TxDOT	1 gal.	5	AM
2/3/2000	0117 (A-E)	PG 70-22	UPS/TxDOT	1 gal.	5	AM
2/29/2000	0141 A-E	MG-30	UPS/TxDOT	1 gal.	5	AM
Cement						
2/2/2000	0113	Type I/II	UPS/TxDOT	5 gal.	1	AM
2/2/2000	0114	Type I	UPS/TxDOT	5 gal.	1	AM
2/2/2000	0115	Type II	UPS/TxDOT	5 gal.	1	AM
2/2/2000	0116	Type I	UPS/TxDOT	5 gal.	1	AM
4/26/2000	0184	Type I	Central Frt	5 gal	1	AM
4/26/2000	0185	Type I	Central Frt	5 gal	1	AM
4/26/2000	0186	Type I	Central Frt	5 gal	1	AM
Fly Ash						
2/8/2000	0120	Class C	UPS/TxDOT	5 gal.	1	AM
2/18/2000	0124	Class F	UPS/TxDOT	5 gal.	1	AM
2/18/2000	0125	Class C	UPS/TxDOT	5 gal.	1	AM
2/18/2000	0126	Class C	UPS/TxDOT	5 gal.	1	AM
2/21/2000	0127	Class F	UPS/TxDOT	5 gal.	1	AM
2/24/2000	0128	Class C	Fed Ex	5 gal.	1	AM
4/17/2000	0179	Class F	Fedex	5 gal	1	AM
4/17/2000	0180	Class F	Fedex	5 gal	1	AM
Aggregate						
2/15/2000	0122	Siliceous Sand	Central Frt.	1 bag	1	AM
2/15/2000	0123	Foundry Sand	Central Frt.	1 bag	1	AM

2/25/2000	0129	Siliceous Sand	Central Frt.	1 bag	1	AM
2/25/2000	0130	Limestone	Central Frt.	1 bag	1	AM
2/25/2000	0131	Limestone	Central Frt.	1 bag	1	AM
2/25/2000	0132	Limestone	Central Frt.	1 bag	1	AM
2/25/2000	0133	Siliceous Sand	Central Frt.	1 bag	1	AM
2/25/2000	0134	Sand	Central Frt.	1 bag	1	AM
2/25/2000	0135	Siliceous Sand	Central Frt.	1 bag	1	AM
2/29/2000	0136	Siliceous Gravel	Central Frt.	1 bag	3	AM
2/29/2000	0137 A-B	Foundary Sand	Central Frt.	1 bag	2	AM
2/29/2000	0138 A-C	Silic. Gravel	Central Frt.	1 bag	3	AM
2/29/2000	0139 A-C	Cliché	Central Frt.	1 bag	3	AM
2/29/2000	0140A-C	Limestone	Central Frt.	1 bag	3	AM
3/3/2000	0148	Sandstone	Central Frt.	1 bag	3	AM
3/3/2000	0153	LRA	Central Frt.	1 bag	1	AM
3/3/2000	0154	LRA Type D	Central Frt.	1 bag	1	AM
3/3/2000	0155	Siliceous Sand	Central Frt.	1 bag	1	AM
3/3/2000	0167	Class C	Central Frt.	5 gal.	1	AM
3/3/2000	0168	Caliche	Central Frt.	1 bag	1	AM
3/24/2000	0169	Caliche	Central Frt	1 bag	3	AM
4/19/2000	0181	Siliceous Gravel	Central Frt	1 bag	2	AM
4/19/2000	0182	Limestone	Central Frt	1 bag	2	AM
4/19/2000	0183	Sandstone	Central Frt	1 bag	3	AM
Lime						
4/10/2000	0171	Type A	UPS	5 gal	1	AM
4/10/2000	0172	Type C	UPS	5 gal	1	AM
4/10/2000	0173	TypeA	UPS	5 gal	1	AM
4/10/2000	0174	Type C	UPS	5 gal	2	AM
4/10/2000	0175	Type A	UPS	5 gal	2	AM
4/10/2000	0176	Type B	UPS	1 gal	5	AM
4/10/2000	0177	Type B	UPS	5 gal	1	AM
4/10/2000	0178	Type C	UPS	5 gal	1	AM
RAP						
5/1/2000	0187	Rap	Central Frt	1 gal	1	AM
7/19/2000	0190	Rap	Sampled	4 bags	4	AM
RCP						
6/1/2000	0188	RCP Dallas	Central Frt	1 gal	1	AM
8/25/2000	191	RCP	Centratl Frt	1 bag	1	AM
ottom Ash						
6/15/2000	0189	DePauw Bottom Ash, Tolk	Pick Up	5 gal	1	AM