G5078

Hess Environmental Laboratories.
Environmentalists and Laboratory Analysts
304 Park Avenue, Stroudsburg, Pennsylvania
Telephone (717) 421-1550

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/7/89
Sample I.D.	:	042 - First Cell Eff.
Time Sampled	:	1100
Sampled By	:	Client
Date Received	:	7/7/89
Lab Sample No.	:	1557

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.067
Lead - Dissolved	----
Copper - Total	0.084

M.L. Klusaritz
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AR101234

ORIGINAL (Red)

Hess Environmental Laboratories.

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304 Park Avenue, Stroudsburg, Pennsylvania 18360
Telephone (717) 421-1550.

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/7/89
Sample I.D.	:	043 - Clairfer Eff.
Time Sampled	:	1045
Sampled By	:	Client
Date Received	:	7/7/89
Lab Sample No.	:	1158

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.163
Lead - Dissolved	----
Copper - Total	0.240

M. L. Klusaritz

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Telephone (717) 421-1550.

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	044 - System Effluent
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1567

RESULTS

Parameter	Result (mg/l)
Antimony	<0.02
Arsenic	0.007
Beryllium	<0.005
Cadmium	0.0013
Copper	0.006
Lead	0.0021
Nickel	0.023
Selenium	<0.003
Silver	0.0037
Zinc	0.022
Aluminum	0.68
Boron	0.16
Tin	0.092
Iron - Total	0.021
Iron - Dissolved	0.020
Phenols - Total	-----

M. L. Klusaritz
Michael L. Klusaritz
Laboratory Director

MLK/dm

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Telephone (717) 421-1550.

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	045 - 8.68
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1568

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.034
Lead - Dissolved	0.017

M. L. Klusaritz
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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	046 - 9.64
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1569

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.054
Lead - Dissolved	0.022

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	047 - 10.75(S)
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1570

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.011
Lead - Dissolved	0.0023

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	048 - 10.83
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1571

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.066
Lead - Dissolved	0.054

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	049 - 11.03
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1572

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.066
Lead - Dissolved	0.054

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ORIGINAL (Red)

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	050 - 11.47
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1573

RESULTS

Parameter	Results (mg/l)
Copper - Dissolved	0.067
Lead - Dissolved	0.067

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Telephone (717) 421-1550.

July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	051 - Pool Eff
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1574

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.0058
Lead - Dissolved	----
Copper - Total	0.008

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/8/89
Sample I.D.	:	052 - Upstream
Time Sampled	:	0800
Sampled By	:	Client
Date Received	:	7/8/89
Lab Sample No.	:	1575

RESULTS

Parameter	Results (mg/l)
Lead - Total	<0.001
Lead - Dissolved	-----
Copper - Total	<0.003

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/10/89
Sample I.D.	:	053 - System Eff
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	7/10/89
Lab Sample No.	:	1601

RESULTS

Parameter	Result (mg/l)
Antimony	<0.02
Arsenic	0.009
Beryllium	<0.005
Cadmium	0.0009
Copper	0.006
Lead	0.0023
Nickel	0.014
Selenium	<0.003
Silver	0.0017
Zinc	0.020
Aluminum	0.63
Boron	<0.10
Tin	0.081
Iron - Total	0.017
Iron - Dissolved	0.014
Phenols - Total	-----

M. J. Klusaritz

Michael J. Klusaritz
Laboratory Director

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MJK/vw

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/10/89
Sample I.D.	:	054 - First Cell Eff
Time Sampled	:	0605
Sampled By	:	Client
Date Received	:	7/10/89
Lab Sample No.	:	1600

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.120
Lead - Dissolved	-----
Copper - Total	0.320

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July 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/10/89
Sample I.D.	:	055 - Second Cell Eff
Time Sampled	:	0607
Sampled By	:	Client
Date Received	:	7/10/89
Lab Sample No.	:	1599

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.036
Lead - Dissolved	-----
Copper - Total	0.071

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ORIGINAL (Red)

July 13, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/12/89
Sample I.D.	:	056 - System Eff
Time Sampled	:	0500
Sampled By	:	Client
Date Received	:	7/12/89
Lab Sample No.	:	1649

RESULTS

Parameter	Result (mg/l)
Antimony	<0.02
Arsenic	0.005
Beryllium	<0.005
Cadmium	0.004
Copper	0.075
Lead	0.013
Nickel	0.088
Selenium	0.004
Silver	0.013
Zinc	0.024
Aluminum	5.99
Boron	0.13
Tin	0.104
Iron - Total	0.20
Iron - Dissolved	0.20
Phenols - Total	-----
Chromium	0.008

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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

July 12, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/12/89
Sample I.D.	:	057 - Second Cell Eff.
Time Sampled	:	0510
Sampled By	:	Client
Date Received	:	7/12/89
Lab Sample No.	:	1650

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.078
Lead - Dissolved	-----
Copper - Total	0.199
Cadmium	0.013
Silver	0.024

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ORIGINAL (Red)

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301 Park Avenue, Stroudsburg, Pennsylvania 18360
Telephone (717) 421-1550

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/13/89
Sample I.D.	:	058 - System Effluent
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/13/89
Lab Sample No.	:	1685

RESULTS

Parameter	Result (mg/l)
Antimony	0.041
Arsenic	0.013
Beryllium	<0.005
Cadmium	0.0017
Copper	0.010
Lead	0.0028
Nickel	0.030
Selenium	0.009
Silver	0.0011
Zinc	0.018
Aluminum	4.10
Boron	<0.10
Tin	0.094
Iron - Total	0.036
Iron - Dissolved	0.030
Phenols - Total	----

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July 13, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/13/89
Sample I.D.	: 059 - First Cell Eff
Time Sampled	: ----
Sampled By	: Client
Date Received	: 7/13/89
Lab Sample No.	: 1683

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.014
Lead - Dissolved	-----
Copper - Total	0.067
Silver - Total	0.012

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July 13, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/13/89
Sample I.D.	:	060 - Pool
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/13/89
Lab Sample No.	:	1684

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.0040
Lead - Dissolved	-----
Copper - Total	0.012
Silver - Total	0.0031

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Telephone (717) 421-1550.

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/14/89
Sample I.D.	:	061 - System Eff
Time Sampled	:	-----
Sampled By	:	Client
Date Received	:	7/14/89
Lab Sample No.	:	1980

RESULTS

Parameter	Result (mg/l)
Antimony	0.034
Arsenic	0.011
Beryllium	<0.005
Cadmium	0.0018
Copper	0.007
Lead	0.0010
Nickel	0.014
Selenium	0.006
Silver	0.0023
Zinc	0.014
Aluminum	2.30
Boron	0.18
Tin	0.075
Iron - Total	0.030
Iron - Dissolved	0.030
Phenols - Total	-----
Chromium	0.0042

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AR101253

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Telephone (717) 421-1550

ORIGINAL (Red)

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/14/89
Sample I.D.	: 062 - 1st Cell Eff.
Time Sampled	: ----
Sampled By	: Client
Date Received	: 7/14/89
Lab Sample No.	: 1981

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.088
Lead - Dissolved	----
Copper - Total	0.206

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July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/14/89
Sample I.D.	:	063 - 2nd Cell Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/14/89
Lab Sample No.	:	1982

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.038
Lead - Dissolved	----
Copper - Total	0.184

M. L. Klusaritz

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Telephone (717) 421-1550

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/14/89
Sample I.D.	:	064 - 3rd Cell Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/14/89
Lab Sample No.	:	1983

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.076
Lead - Dissolved	----
Copper - Total	0.190

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Telephone (717) 421-1550.

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/14/89
Sample I.D.	:	065 - 4th Cell Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/14/89
Lab Sample No.	:	1984

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.0022
Lead - Dissolved	----
Copper - Total	0.012

M. L. Klusaritz

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Hess Environmental Laboratories.

Environmental and Laboratory Analysis
304 Park Avenue, Strasburg, Pennsylvania
Telephone 717 421 1550

July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/17/89
Sample I.D.	:	066 - System Effluent
Time Sampled	:	0500
Sampled By	:	Client
Date Received	:	7/17/89
Lab Sample No.	:	2440

RESULTS

Parameter	Result (mg/l)
Antimony	0.038
Arsenic	0.017
Beryllium	<0.005
Cadmium	0.0036
Copper	0.008
Lead	0.0023
Nickel	0.022
Selenium	0.007
Silver	0.0028
Zinc	<0.005
Aluminum	10.1
Boron	0.24
Tin	0.427
Iron - Total	0.080
Iron - Dissolved	0.071
Phenols - Total	-----
Chromium	0.017

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July 18, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/17/89
Sample I.D.	:	067 - Carbon Filter
Time Sampled	:	0530
Sampled By	:	Client
Date Received	:	7/17/89
Lab Sample No.	:	2441

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.056
Cadmium - Total	0.014
Copper - Total	0.042
Silver - Total	0.026

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AR101259

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Telephone (717) 421-1550

ORIGINAL (Red)

July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/19/89
Sample I.D.	:	068 - System Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/19/89
Lab Sample No.	:	2607

RESULTS

Parameter	Result (mg/l)
Antimony	0.130
Arsenic	0.038
Beryllium	<0.005
Cadmium	<0.001
Copper	0.004
Lead	0.0013
Nickel	0.021
Selenium	0.017
Silver	0.0024
Zinc	0.008
Aluminum	2.14
Boron	<0.10
Tin	1.38
Iron - Total	<0.01
Iron - Dissolved	<0.01
Phenols - Total	----
Chromium	0.003

M. L. Klusaritz

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AR101260

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July 20, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/19/89
Sample I.D.	: 069- Carbon Filter Eff
Time Sampled	: ――――
Sampled By	: Client
Date Received	: 7/19/89
Lab Sample No.	: 2608

RESULTS

Parameter	Results (mg/l)
Copper	0.194
Cadmium	0.015
Lead	0.080
Silver	0.004

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ORIGINAL (Red)

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Telephone (717) 421-1550.

July 20, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/19/89
Sample I.D.	: 070 - Raw Water
Time Sampled	: -----
Sampled By	: Client
Date Received	: 7/19/89
Lab Sample No.	: 2609

RESULTS

Parameter	Results (mg/l)
Copper	11.70
Cadmium	7.65
Lead	4.19
Silver	0.020

M. L. Klusaritz

Michael L. Klusaritz
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HESS ENVIRONMENTAL LABORATORIES

AR101262

ORIGINAL (Red)

Hess Environmental Laboratories.

[illegible]
[illegible]
[illegible]

July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/21/89
Sample I.D.	:	071 - System Eff.
Time Sampled	:	0400
Sampled By	:	Client
Date Received	:	7/21/89
Lab Sample No.	:	2769

RESULTS

Parameter	Result (mg/l)
Antimony	0.22
Arsenic	0.012
Beryllium	<0.005
Cadmium	0.003
Copper	<0.001
Lead	0.0020
Nickel	0.010
Selenium	0.052
Silver	<0.001
Zinc	0.008
Aluminum	4.27
Boron	0.19
Tin	2.21
Iron - Total	0.071
Iron - Dissolved	0.064
Phenols - Total	0.005
Chromium	0.003

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ORIGINAL (Red)

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104 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

July 21, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/21/89
Sample I.D.	:	072 - Carbon Cell Eff
Time Sampled	:	0405
Sampled By	:	Client
Date Received	:	7/21/89
Lab Sample No.	:	2770

RESULTS

Parameter	Results (mg/l)
Copper	0.237
Cadmium	0.022
Lead	0.109
Silver	0.020

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July 21, 1989

Holiday Inn
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Route 309 North
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Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/21/89
Sample I.D.	: 073 - First Cell Eff
Time Sampled	: 0410
Sampled By	: Client
Date Received	: 7/21/89
Lab Sample No.	: 2771

RESULTS

Parameter	Results (mg/l)
Copper	0.059
Cadmium	0.009
Lead	0.081
Silver	0.011

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August 4,1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-24-89
Sample I.D.	:	074 - Effluent To Pool
Time Sampled	:	0300
Sampled By	:	Client
Date Received	:	7-24-89
Lab Sample No.	:	3203

RESULTS

Parameter	Result (mg/l)
Antimony	0.590
Arsenic	0.094
Beryllium	<0.005
Cadmium	0.009
Copper	0.84
Lead	0.100
Nickel	0.071
Selenium	0.021
Silver	0.004
Zinc	0.18
Aluminum	8.12
Boron	0.17
Tin	0.230
Iron - Total	1.62
Iron - Dissolved	1.60
Phenols - Total	0.007
Chromium	0.004

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July 26, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/24/89
Sample I.D.	:	075 - First Poly Tank
Time Sampled	:	0330
Sampled By	:	Client
Date Received	:	7/24/89
Lab Sample No.	:	3204

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.160
Lead - Dissolved	----
Copper - Total	0.420

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July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/24/89
Sample I.D.	:	076 - Second Poly Tank
Time Sampled	:	0335
Sampled By	:	Client
Date Received	:	7/24/89
Lab Sample No.	:	3205

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.091
Lead - Dissolved	----
Copper - Total	0.042

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July 26, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/24/89
Sample I.D.	:	077 - First Cell Eff.
Time Sampled	:	0340
Sampled By	:	Client
Date Received	:	7/24/89
Lab Sample No.	:	3206

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.053
Lead - Dissolved	----
Copper - Total	0.022

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July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/24/89
Sample I.D.	: 078 - Second Cell Eff.
Time Sampled	: 0345
Sampled By	: Client
Date Received	: 7/24/89
Lab Sample No.	: 3207

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.071
Lead - Dissolved	----
Copper - Total	0.030

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July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/24/89
Sample I.D.	:	079 - Third Cell Eff.
Time Sampled	:	0350
Sampled By	:	Client
Date Received	:	7/24/89
Lab Sample No.	:	3208

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.042
Lead - Dissolved	----
Copper - Total	0.033

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ORIGINAL (Red)

July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/24/89
Sample I.D.	: 080 - Fourth Cell Eff.
Time Sampled	: 0355
Sampled By	: Client
Date Received	: 7/24/89
Lab Sample No.	: 3209

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.121
Lead - Dissolved	----
Copper - Total	0.110
Silver - Total	0.010

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Telephone 717 [illegible]

July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/25/89
Sample I.D.	:	081 - Fourth Cell Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/25/89
Lab Sample No.	:	3273

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.180
Lead - Dissolved	----
Copper - Total	0.090

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ORIGINAL (Red)

July 26, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/25/89
Sample I.D.	:	082 - First Poly Tank
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/25/89
Lab Sample No.	:	3274

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.422
Lead - Dissolved	----
Copper - Total	0.837

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July 26, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/25/89
Sample I.D.	:	083 - Second Poly Tank
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/25/89
Lab Sample No.	:	3275

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.163
Lead - Dissolved	----
Copper - Total	0.224

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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	: 7/25/89
Sample I.D.	: 084 - First Cell Eff.
Time Sampled	: ----
Sampled By	: Client
Date Received	: 7/25/89
Lab Sample No.	: 3276

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.204
Lead - Dissolved	----
Copper - Total	0.225

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July 26, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7/25/89
Sample I.D.	:	085 - Second Cell Eff.
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7/25/89
Lab Sample No.	:	3277

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.178
Lead - Dissolved	----
Copper - Total	0.093

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-25-89
Sample I.D.	:	086 - System Effluent
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	7-25-89
Lab Sample No.	:	3278

RESULTS

Parameter	Result (mg/l)
Antimony	0.054
Arsenic	0.064
Beryllium	<0.005
Cadmium	0.0015
Copper	0.010
Lead	0.0017
Nickel	0.044
Selenium	0.013
Silver	0.0023
Zinc	0.034
Aluminum	7.14
Boron	0.13
Tin	0.50
Iron - Total	0.075
Iron - Dissolved	0.075
Phenols - Total	0.008
Chromium	0.014

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-27-89
Sample I.D.	:	087 - System Effluent Pool
Time Sampled	:	0545
Sampled By	:	Client
Date Received	:	7-27-89
Lab Sample No.	:	3347

RESULTS

Parameter	Result (mg/l)
Antimony	0.11
Arsenic	0.076
Beryllium	<0.005
Cadmium	0.010
Copper	0.016
Lead	0.041
Nickel	0.062
Selenium	0.089
Silver	0.0056
Zinc	0.028
Aluminum	5.68
Boron	0.20
Tin	0.601
Iron - Total	0.18
Iron - Dissolved	0.15
Phenols - Total	0.002
Chromium	0.010

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ORIGINAL (Red)

August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-27-89
Sample I.D.	:	088 - First Cell Effluent
Time Sampled	:	0555
Sampled By	:	Client
Date Received	:	7-27-89
Lab Sample No.	:	3348

RESULTS

Parameter	Results (mg/l)
Copper	0.159
Lead	0.127

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-27-89
Sample I.D.	:	089 - Second Cell Effluent
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	7-27-89
Lab Sample No.	:	3349

RESULTS

Parameter	Results (mg/l)
Copper	0.183
Lead	0.134

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-27-89
Sample I.D.	:	090 - Third Cell Effluent
Time Sampled	:	0605
Sampled By	:	Client
Date Received	:	7-27-89
Lab Sample No.	:	3350

RESULTS

Parameter	Results (mg/l)
Copper	0.128
Lead	0.112

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-27-89
Sample I.D.	:	092 - Treated Tank Water
Time Sampled	:	0615
Sampled By	:	Client
Date Received	:	7-27-89
Lab Sample No.	:	3352

RESULTS

Parameter	Result (mg/l)
Antimony	0.38
Arsenic	0.19
Beryllium	<0.005
Cadmium	0.339
Copper	0.40
Lead	2.08
Nickel	0.63
Selenium	0.13
Silver	0.084
Zinc	5.18
Aluminum	45.5
Boron	0.47
Tin	6.11
Iron - Total	1.30
Iron - Dissolved	1.26
Phenols - Total	----
Chromium	0.16

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-28-89
Sample I.D.	:	093 - System Effluent
Time Sampled	:	0400
Sampled By	:	Client
Date Received	:	7-28-89
Lab Sample No.	:	3381

RESULTS

Parameter	Result (mg/l)
Antimony	0.054
Arsenic	0.051
Beryllium	<0.005
Cadmium	0.0060
Copper	0.016
Lead	0.0029
Nickel	0.039
Selenium	0.020
Silver	0.0015
Zinc	0.025
Aluminum	3.04
Boron	0.17
Tin	0.390
Iron - Total	0.062
Iron - Dissolved	0.050
Phenols - Total	0.002
Chromium	0.004

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August 4, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-28-89
Sample I.D.	:	094 - Clean Pool
Time Sampled	:	0500
Sampled By	:	Client
Date Received	:	7-28-89
Lab Sample No.	:	3382

RESULTS

Parameter	Result (mg/l)
Antimony	0.31
Arsenic	0.038
Beryllium	<0.005
Cadmium	0.004
Copper	0.006
Lead	0.005
Nickel	0.027
Selenium	0.014
Silver	0.0011
Zinc	0.022
Aluminum	2.08
Boron	<0.10
Tin	0.206
Iron - Total	0.090
Iron - Dissolved	0.088
Phenols - Total	0.008
Chromium	0.010

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-28-89
Sample I.D.	:	095 - Second Cell Effluent
Time Sampled	:	0505
Sampled By	:	Client
Date Received	:	7-28-89
Lab Sample No.	:	3383

RESULTS

Parameter	Results (mg/l)
Copper	0.123
Lead	0.136

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August 4, 1989

Holiday Inn
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Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-28-89
Sample I.D.	:	096 - Clarifier Effluent
Time Sampled	:	0515
Sampled By	:	Client
Date Received	:	7-28-89
Lab Sample No.	:	3384

RESULTS

Parameter	Results (mg/l)
Copper	0.109
Lead	0.128

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[illegible] Park [illegible]
Telephone [illegible]

August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-31-89
Sample I.D.	:	097 - System Effluent
Time Sampled	:	1110
Sampled By	:	Client
Date Received	:	7-31-89
Lab Sample No.	:	3858

from trial run of tank water

RESULTS

Parameter	Result (mg/l)
Antimony	0.14
Arsenic	0.012
Beryllium	0.006
Cadmium	0.025
Copper	1.19
Lead	0.101
Nickel	0.41
Selenium	0.027
Silver	0.0092
Zinc	0.035
Aluminum	1890
Boron	0.83
Tin	0.052
Iron - Total	1.17
Iron - Dissolved	1.15
Phenols - Total	——
Chromium	0.048

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-31-89
Sample I.D.	:	098 - System Effluent
Time Sampled	:	1230
Sampled By	:	Client
Date Received	:	7-31-89
Lab Sample No.	:	3859

RESULTS

Parameter	Results (mg/l)
Lead	0.210
Zinc	0.048

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-31-89
Sample I.D.	:	099 - Systems Effluent
Time Sampled	:	1330
Sampled By	:	Client
Date Received	:	7-31-89
Lab Sample No.	:	3860

RESULTS

Parameter	Results (mg/l)
Cadmium	0.007
Selenium	0.025

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August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	7-31-89
Sample I.D.	:	100 - System Effluent
Time Sampled	:	1430
Sampled By	:	Client
Date Received	:	7-31-89
Lab Sample No.	:	3861

RESULTS

Parameter	Result (mg/l)
Antimony	0.048
Arsenic	0.032
Beryllium	<0.005
Cadmium	0.010
Copper	0.022
Lead	0.067
Nickel	0.20
Selenium	0.012
Silver	0.0063
Zinc	0.112
Aluminum	112.
Boron	<0.10
Tin	0.017
Iron - Total	0.43
Iron - Dissolved	0.39
Phenols - Total	——
Chromium	0.010
Sulfate	46,780

Michael L. Klusaritz
Laboratory Director

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ORIGINAL (Red)

Hess Environmental Laboratories.

Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-4550.

August 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	8-3-89
Sample I.D.	:	101 - System Effluent
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	8-3-89
Lab Sample No.	:	3929

RESULTS

Parameter	Result (mg/l)
Antimony	0.043
Arsenic	0.021
Beryllium	<0.005
Cadmium	0.0080
Copper	0.010
Lead	0.0018
Nickel	0.050
Selenium	0.017
Silver	<0.001
Zinc	0.006
Aluminum	0.26
Boron	0.12
Tin	0.022
Iron - Total	0.020
Iron - Dissolved	0.020
Phenols - Total	0.004
Chromium	0.004

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Laboratory Director

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Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

August 4, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	8-3-89
Sample I.D.	:	103 - Small Tank
Time Sampled	:	0610
Sampled By	:	Client
Date Received	:	8-3-89
Lab Sample No.	:	3931

RESULTS

Parameter	Results (mg/l)
Lead	0.350

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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421 1550.

ORIGINAL (Red)

August 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	8-8-89
Sample I.D.	:	104 - System Effluent
Time Sampled	:	0605
Sampled By	:	Client
Date Received	:	8-9-89
Lab Sample No.	:	4589

RESULTS

Parameter	Result (mg/l)
Antimony	0.010
Arsenic	0.031
Beryllium	<0.005
Cadmium	0.0025
Copper	0.028
Lead	0.0024
Nickel	<0.005
Selenium	0.012
Silver	<0.001
Zinc	0.005
Aluminum	0.65
Boron	<0.10
Tin	0.128
Iron - Total	0.016
Iron - Dissolved	0.016
Phenols - Total	0.004
Chromium	<0.005

Michael L. Klusaritz
Laboratory Director

MLK/dem

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ORIGINAL (Red)

Hess Environmental Laboratories.
Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

August 25, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Sludge

Re: Wastewater Analysis

Date Sampled	:	8/8/89
Sample I.D.	:	105 - Lagoon
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	8/9/89
Lab Sample No.	:	5049

RESULTS

Parameter	Results
Color	Gray
Single Phase	Solid
Density Bulk	1.27 g/cc
Solids - Total	70.8 wt%

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304 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

ORIGINAL (Red)

August 28, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	8/8/89
Sample I.D.	:	105 - Lagoon
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	8/9/89
Lab Sample No.	:	5049

RESULTS

Parameter	Results
Ignitibility	See Note I
Corrosivity	See Note II
Reactivity	See Note III

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Laboratory Director
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ORIGINAL (Red)

Sample I. D. : 105 - Lagoon

I. Ignitibilty

The sample does not spontaneously ignite when exposed to air or water.

The sample did not ignite or smolder when being exposed to a Bunsen flame for ten seconds.

Presently, no EPA approved method exists to determine if a solid is "ignitable". The EPA has approved methods to determine "ignitability" only on liquids. Therefore, this test alone does not indicate whether the material is ignitable as defined by RCRA in the Federal Register, May 19, 1980, Section 261.21.

II. Corrosivity

The pH of a 1:1 slurry was 6.2, indicating that the waste is not corrosive.

III. Reactivity

The acidified sample was distilled and the resulting vapors were absorbed in a sodium hydroxide solution. This solution was analyzed for cyanide and sulfide. This waste is not considered reactive and hazardous because it does not generate a quantity of cyanide exceeding 250ppm or sulfide exceeding 500 ppm. These interim threshold limits were established by the Solid Waste Branch of EPA, July 12, 1985.

Parameter	Result (mg/kg)
Cyanide	<0.20
Sulfide	6.5

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ORIGINAL (Red)

August 28, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	8/8/89
Sample I.D.	:	105 - Lagoon
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	8/9/89
Lab Sample No.	:	5049

RESULTS

Parameter	Results (mg/kg)
Reactive Cyanide	<0.20
Total Cyanide	4.6
Reactive Sulfide	6.5
Total Sulfide	107.
Total Phenols	0.24

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ORIGINAL (Red)

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Environmentalists and Laboratory Analysts.
304 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

August 25, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601

Attn: Joe Galioto

ORGANIC PRIORITY POLLUTANT RESULTS

I. VOLATILES	RESULTS (ug/kg)
Acrolein	<100.
Acrylonitrile	<100.
Benzene	<5.0
Bromoform	<5.0
Carbon Tetrachloride	<5.0
Chlorobenzene	<5.0
Chlorodibromomethane	<5.0
Chloroethane	<10.
2-Chloroethylvinyl ether	<10.
Chloroform	<5.0
cis-1,3-Dichloropropylene	<5.0
Dichlorobromomethane	<5.0
1,1-Dichloroethane	<5.0
1,2-Dichloroethane	<5.0
1,1-Dichloroethylene	<5.0
1,2-Dichloropropane	<5.0
Ethylbenzene	<5.0
Methyl bromide	<10.
Methyl chloride	<10.
Methylene chloride	<5.0
1,1,2,2-Tetrachloroethane	<5.0
Tetrachloroethylene	<5.0
Toluene	<5.0
1,2-trans-Dichloroethylene	<5.0
trans-1,3-Dichloropropylene	<5.0
1,1,1-Trichloroethane	<5.0
1,1,2-Trichloroethane	<5.0
Trichloroethylene	<5.0
Trichlorofluoromethane	<5.0
Vinyl chloride	<10.

Sample I.D. : 105 - Lagoon
Date Sampled : 8-8-89 @ 0600
Sampled By : Client
Sample Type : Sludge

Michael P. Klusz
Laboratory Director

AR101299

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Sample I.D. No. : 105 - Lagoon

ORGANIC PRIORITY POLLUTANT RESULTS (DRY BASIS)

II. ACID COMPOUNDS	RESULTS (ug/kg)
2-Chlorophenol	<200.
2,4-Dichlorophenol	<200.
2,4-Dimethylphenol	<200.
4,6-Dinitro-o-cresol	<200.
2,4-Dinitrophenol	<500.
2-Nitrophenol	<200.
4-Nitrophenol	<200.
p-Chloro-m-cresol	<200.
Pentachlorophenol	<500.
Phenol	<200.
2,4,6-Trichlorophenol	<200.

Michael P. Klusaty
Laboratory Director

AR101300

ORIGINAL (Red)

Sample I.D. No. : 105 - Lagoon

ORGANIC PRIORITY POLLUTANTS RESULTS (DRY BASIS)

III. BASE/NEUTRALS	RESULTS (ug/kg)
Acenaphthene	<400.
Acenaphthylene	<400.
Anthracene	<400.
Benzidine	<400.
Benzo(a)anthracene	<400.
Benzo(a)pyrene	<400.
3,4-Benzofluoranthene	<400.
Benzo(ghi)perylene	<400.
Benzo(k)fluoranthene	<400.
bis(2-Chloroethoxy)methane	<400.
bis(2-Chloroethyl)ether	<400.
bis(2-Chloroisopropyl)ether	<400.
bis(2-Ethylhexyl)phthalate	<400.
4-Bromophenyl phenyl ether	<400.
Butylbenzyl phthalate	<400.
2-Chloronaphthalene	<400.
4-Chlorophenyl phenyl ether	<400.
Chrysene	<400.
Dibenzo(a,h)anthracene	<400.
1,2-Dichlorobenzene	<400.
1,3-Dichlorobenzene	<400.
1,4-Dichlorobenzene	<400.
3,3'-Dichlorobenzidine	<400.
Diethyl phthalate	<400.
Dimethyl phthalate	<400.
Di-n-butyl phthalate	<400.
2,4-Dinitrotoluene	<400.
2,6-Dinitrotoluene	<400.
Di-n-octyl phthalate	<400.
1,2-Diphenylhydrazine (as azobenzene)	<400.
Fluoranthrene	<400.
Fluorene	<400.
Hexachlorobenzene	<400.
Hexachlorobutadiene	<400.
Hexachlorocyclopentadiene	<400.
Hexachloroethane	<400.
Indeno(1,2,3-cd)pyrene	<400.
Isophorone	<400.
Naphthalene	<400.
Nitrobenzene	<400.
N-nitrosodimethylamine	<400.
N-nitrosodi-n-propylamine	<400.
N-nitrosodiphenylamine	<400.
Phenanthrene	<400.
Pyrene	<400.
1,2,4-Trichlorobenzene	<400.

Michael S. [signature]

Laboratory Director

Sample I.D. No. : 105 - Lagoon

ORIGINAL (Red)

ORGANIC PRIORITY POLLUTANT RESULTS (DRY BASIS)

IV. PESTICIDES	RESULTS (ug/kg)
Aldrin	<1.0
Alpha-BHC	<1.0
Beta-BHC	<1.0
Gamma-BHC	<1.0
Delta-BHC	<1.0
Chlordane	<2.5
4,4'-DDT	<1.0
4,4'-DDE	<1.0
4,4'-DDD	<1.0
Dieldrin	<1.0
Alpha-endosulfan	<1.0
Beta-endosulfan	<1.0
Endosulfan sulfate	<2.5
Endrin	<1.0
Endrin aldehyde	<1.0
Heptachlor	<1.0
Heptachlor epoxide	<1.0
PCB-1242	<10.
PCB-1254	<10.
PCB-1221	<10.
PCB-1232	<10.
PCB-1248	<10.
PCB-1260	<10.
PCB-1016	<10.
Toxaphene	<10.

Michael J. Klusaty
Laboratory Director

ORIGINAL (Red)

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Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

August 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	8-25-89
Sample I.D.	:	108 - Clean Pool
Time Sampled	:	0730
Sampled By	:	Client
Date Received	:	8-25-89
Lab Sample No.	:	6208

RESULTS

Parameter	Result (mg/l)
Antimony	0.013
Arsenic	0.003
Beryllium	<0.005
Cadmium	0.0024
Copper	0.004
Lead	0.0016
Nickel	0.020
Selenium	0.006
Silver	0.0019
Zinc	0.006
Aluminum	0.011
Boron	<0.10
Tin	0.302
Iron - Total	<0.005
Iron - Dissolved	<0.005
Phenols - Total	0.005
Chromium	0.003

M. L. Klusaritz

Michael L. Klusaritz
Laboratory Director

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Environmentalists and Laboratory Analysts.
304 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

ORIGINAL (Red)

August 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Matt McCloskey

Re: Wastewater Analysis

Date Sampled	:	8-25-89
Sample I.D.	:	109 - Eff Second Cell
Time Sampled	:	0730
Sampled By	:	Client
Date Received	:	8-25-89
Lab Sample No.	:	6209

RESULTS

Parameter	Results (mg/l)
Lead - Total	0.170
Copper - Total	0.051

M. L. Klusaritz

Michael L. Klusaritz
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HESS ENVIRONMENTAL LABORATORIES

AR101304

ORIGINAL (Red)

Hess Environmental Laboratories.
Environmentalists and Laboratory Analysts
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

Plastic Chips from Tonolli: Storage Pile

September 13,1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	8/25/89
Sample I.D.	:	110
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	8/25/89
Lab Sample No.	:	6920

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	138.
Cadmium	12.0
Chromium	19.9
Mercury	0.020
Silver	2.70
Lead	39,300
Selenium	6.34
Copper	185.
Nickel	49.1
Zinc	457.
Thallium	5.65
Beryllium	<1.0
Antimony	78.1
Aluminum	416.
Tin	101.
Moisture Loss @ 105°C	2.19 wt%

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304 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

September 13, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Solids Analysis

Date Sampled	:	8/25/89
Sample I.D.	:	110
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	8/25/89
Lab Sample No.	:	6920

RESULTS

Parameter	Results (mg/l)
Dioxin (Qual. Screen)	Not Detected

Note: EPA Method No. 625

M. L. Klusaritz
Michael L. Klusaritz
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ORIGINAL Rec'd

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Telephone (717) 421-1550.

September 13, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	8/25/89
Sample I.D.	:	111
Time Sampled	:	----
Sampled By	:	Client
Date Received	:	8/25/89
Lab Sample No.	:	6921

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	298.
Cadmium	22.4
Chromium	37.7
Mercury	0.18
Silver	2.56
Lead	32,400
Selenium	1.43
Copper	876.
Nickel	109.
Zinc	248.
Thallium	2.86
Beryllium	<1.0
Antimony	64.9
Aluminum	306.
Tin	148.
Moisture Loss @ 105°C	5.21 wt%

Laboratory Director
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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

September 15,1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Solids Analysis

Date Sampled	:	8/25/89
Sample I.D.	:	111
Time Sampled	:	-----
Sampled By	:	Client
Date Received	:	8/25/89
Lab Sample No.	:	6921

RESULTS

Parameter	Results (mg/l)
Dioxin (Qual. Screen)	Not Detected

Note: EPA Method No. 625

M.L. Klusaritz

Michael L. Klusaritz
Laboratory Director
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ORIGINAL (Red)

Hess Environmental Laboratories.

Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

September 15, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9/1/89
Sample I.D.	:	112 - Clean Pool
Time Sampled	:	0530
Sampled By	:	Client
Date Received	:	9/1/89
Lab Sample No.	:	6975

RESULTS

Parameter	Result (mg/l)
Antimony	0.012
Arsenic	0.035
Beryllium	<0.003
Cadmium	0.006
Copper	0.003
Lead	0.014
Nickel	0.022
Selenium	0.014
Silver	0.003
Zinc	0.008
Aluminum	0.042
Boron	<0.10
Tin	0.098
Iron - Total	<0.005
Iron - Dissolved	<0.005
Phenols - Total	<0.001
Chromium	0.027

Michael L. Klusaritz
Laboratory Director

ORIGINAL (Red)

Hess Environmental Laboratories
Environmentalists and Laboratory Analysts
112 North Courtland Street. PO. Box 268. East Stroudsburg. Pennsylvania 18301
Phone (717) 421-1550. Fax (717) 421-6720

September 15, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re:

Date Sampled	:	9/1/89
Sample I.D.	:	113 - 2nd Cell Eff.
Time Sampled	:	0535
Sampled By	:	Client
Date Received	:	9/1/89
Lab Sample No.	:	6976

RESULTS

Parameter	Results (mg/l)
Lead	0.464
Copper	0.174

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M. P. Klust
Laboratory Director
HESS ENVIRONMENTAL LABORATORIES

PAGE.002

ORIGINAL (Red)

Hess Environmental Laboratories.

Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360
Telephone (717) 421 1550.

Holiday Inn
Re: ORM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9/5/89
Sample I.D.	:	114 - Clean Pool
Time Sampled	:	0630
Sampled By	:	Client
Date Received	:	9/5/89
Lab Sample No.	:	7004

RESULTS

Parameter	Result (mg/l)
Antimony	0.011
Arsenic	0.019
Beryllium	<0.005
Cadmium	<0.001
Copper	0.0024
* Lead	0.0036
Nickel	0.0052
Selenium	0.012
Silver	<0.001
Zinc	0.003
Aluminum	0.060
Boron	<0.10
Tin	0.026
Iron - Total	<0.005
Iron - Dissolved	<0.005
Phenols - Total	0.012
Chromium	<0.001

* Approved to discharge at 10 gpm by PADER (Fosco & Babel) on 9/6/89. Rate is less than half the originally approved discharge rate (25 gpm). Lead limit at low-flow is 1.8 ppb. [signature] 9/7/89

Michael L. Klusaritz
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ORIGINAL (Red)

Hess Environmental Laboratories

Environmentalists and Laboratory Analysts
112 North Courtland Street, P.O. Box 268, East Stroudsburg, Pennsylvania 18301
Phone (717) 421-1550, Fax (717) 421-6720

October 30, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re:

Date Sampled	:	9/6/89
Sample I.D.	:	115 - Clean Pool
Time Sampled	:	0600
Sampled By	:	Client
Date Received	:	9/6/99
Lab Sample No.	:	7051

RESULTS

Parameter	Result (mg/l)
Lead	0.29

Note: **Remaining Metals not analyzed as per J.G.**

M. P. Kluss

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AR101312

Hess Environmental Laboratories.
ORIGINAL (Red)
Environmentalists and Laboratory Analysts.
1904 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

September 20, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9/18/89
Sample I.D.	:	119 - Fire Water
Time Sampled	:	0540
Sampled By	:	Client
Date Received	:	9/18/89
Lab Sample No.	:	7293

RESULTS

Parameter	Result (mg/l)
Antimony	<0.002
Arsenic	0.005
Beryllium	<0.001
Cadmium	0.0013
Copper	0.007
Lead	0.005
Nickel	<0.001
Selenium	<0.003
Silver	<0.0005
Zinc	0.012
Aluminum	0.22
Boron	<0.10
Tin	0.003
Iron - Total	0.12
Iron - Dissolved	0.07
Phenols - Total	<0.001
Chromium	<0.001

M.L. Klusaritz
Michael L. Klusaritz
Laboratory Director

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ORIGINAL (Red)

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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

September 20, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9/18/89
Sample I.D.	:	120 - Clean Pool
Time Sampled	:	0550
Sampled By	:	Client
Date Received	:	9/18/89
Lab Sample No.	:	7294

RESULTS

Parameter	Result (mg/l)
Antimony	<0.002
Arsenic	0.022
Beryllium	<0.001
Cadmium	0.0010
Copper	0.002
Lead	0.003
Nickel	<0.001
Selenium	0.004
Silver	<0.0005
Zinc	<0.005
Aluminum	0.020
Boron	<0.10
Tin	0.008
Iron - Total	<0.010
Iron - Dissolved	<0.010
Phenols - Total	0.011
Chromium	<0.001

M. L. Klusaritz

Michael L. Klusaritz
Laboratory Director

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ORIGINAL (Red)

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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

September 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled : 9-19-89
Sample I.D. : 121
Time Sampled : 1300
Sampled By : Client
Date Received : 9-20-89
Lab Sample No. : 7360

RESULTS

Parameter	Result (mg/l)
Antimony	<0.002
Arsenic	0.004
Beryllium	<0.001
Cadmium	0.0031
Copper	0.020
Lead	0.003
Nickel	<0.001
Selenium	<0.003
Silver	<0.001
Zinc	0.18
Aluminum	<0.02
Boron	<0.10
Tin	<0.001
Iron - Total	0.91
Iron - Dissolved	0.05
Phenols - Total	0.009
Chromium	<0.001

Michael L. Klusaritz
Laboratory Director

MLK/dm

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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

ORIGINAL (Red)

September 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	122
Time Sampled	:	1310
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7361

RESULTS

Parameter	Result (mg/l)
Antimony	<0.002
Arsenic	<0.003
Beryllium	<0.001
Cadmium	<0.001
Copper	0.006
Lead	<0.001
Nickel	<0.001
Selenium	<0.003
Silver	<0.001
Zinc	0.030
Aluminum	<0.02
Boron	<0.10
Tin	<0.001
Iron - Total	0.16
Iron - Dissolved	<0.01
Phenols - Total	<0.005
Chromium	<0.001

Michael L. Klusaritz
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ART01316

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Route 309 North
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Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	123
Time Sampled	:	1320
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7362

RESULTS

Parameter	Result (mg/l)
Antimony	<0.002
Arsenic	<0.003
Beryllium	<0.001
Cadmium	0.0161
Copper	0.007
Lead	0.009
Nickel	<0.001
Selenium	<0.003
Silver	<0.001
Zinc	0.041
Aluminum	0.19
Boron	0.14
Tin	0.018
Iron - Total	0.62
Iron - Dissolved	0.44
Phenols - Total	0.012
Chromium	0.001

M. L. Klusaritz

Michael L. Klusaritz
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September 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	124
Time Sampled	:	1330
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7363

RESULTS

Parameter	Result (mg/l)
Antimony	0.028
Arsenic	0.011
Beryllium	<0.001
Cadmium	0.0482
Copper	0.53
Lead	15.60
Nickel	0.051
Selenium	0.007
Silver	0.0026
Zinc	6.50
Aluminum	<0.02
Boron	0.34
Tin	0.075
Iron - Total	0.49
Iron - Dissolved	0.35
Phenols - Total	0.008
Chromium	0.078

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Holiday Inn
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Route 309 North
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Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	125
Time Sampled	:	1340
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7364

RESULTS

Parameter	Result (mg/l)
Antimony	0.004
Arsenic	<0.003
Beryllium	<0.001
Cadmium	0.002
Copper	<0.002
Lead	0.006
Nickel	<0.001
Selenium	0.004
Silver	<0.001
Zinc	0.052
Aluminum	<0.02
Boron	<0.10
Tin	0.007
Iron - Total	0.35
Iron - Dissolved	0.05
Phenols - Total	<0.005
Chromium	<0.001

M. L. Klusaritz

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Route 309 North
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Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	: 9-19-89
Sample I.D.	: 126
Time Sampled	: 1350
Sampled By	: Client
Date Received	: 9-20-89
Lab Sample No.	: 7365

RESULTS

Parameter	Result (mg/l)
Antimony	0.018
Arsenic	0.002
Beryllium	0.063
Cadmium	1.63
Copper	95.3
Lead	0.07
Nickel	0.010
Selenium	0.0083
Silver	1.20
Zinc	2.37
Aluminum	0.25
Boron	0.34
Tin	16.8
Iron - Total	0.34
Iron - Dissolved	0.022
Phenols - Total	0.170
Chromium	

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Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	127
Time Sampled	:	1400
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7366

RESULTS

Parameter	Result (mg/kg)
Antimony	9.32
Arsenic	26.4
Beryllium	1.8
Cadmium	546.
Copper	1,400
Lead	18,200
Nickel	58.8
Selenium	14.8
Silver	11.3
Zinc	1420
Aluminum	1140
Boron	2.6
Tin	214.
Iron - Total	654.
Iron - Dissolved	----
Phenols - Total	2.38
Chromium	80.8

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September 29, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	128
Time Sampled	:	1410
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7367

RESULTS

Parameter	Result (mg/kg)
Antimony	5.86
Arsenic	11.3
Beryllium	0.7
Cadmium	34.3
Copper	139.
Lead	293.
Nickel	34.0
Selenium	6.15
Silver	2.06
Zinc	141.
Aluminum	2050
Boron	4.3
Tin	48.7
Iron - Total	10,600
Iron - Dissolved	----
Phenols - Total	0.28
Chromium	9.1

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ORIGINAL Red

September 29, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	129
Time Sampled	:	1420
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7368

RESULTS

Parameter	Result (mg/l)
Antimony	0.024
Arsenic	0.048
Beryllium	0.003
Cadmium	0.049
Copper	9.34
Lead	83.51
Nickel	0.44
Selenium	0.024
Silver	0.010
Zinc	9.14
Aluminum	23.30
Boron	0.45
Tin	0.74
Iron - Total	104.
Iron - Dissolved	2.15
Phenols - Total	0.040
Chromium	0.24

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September 29, 1989

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Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	131
Time Sampled	:	1430
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7358

RESULTS

Parameter	Result (mg/l)
Antimony	0.007
Arsenic	0.009
Beryllium	<0.001
Cadmium	0.0036
Copper	0.006
Lead	0.003
Nickel	0.050
Selenium	0.005
Silver	<0.001
Zinc	0.72
Aluminum	<0.02
Boron	0.14
Tin	0.005
Iron - Total	9.05
Iron - Dissolved	0.15
Phenols - Total	0.061
Chromium	0.010

M.P. Klusaritz

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September 29, 1989

Holiday Inn
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Route 309 North
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Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	: 9-19-89
Sample I.D.	: 132
Time Sampled	: 1440
Sampled By	: Client
Date Received	: 9-20-89
Lab Sample No.	: 7359

RESULTS

Parameter	Result (mg/l)
Antimony	0.019
Arsenic	0.013
Beryllium	<0.001
Cadmium	0.0020
Copper	0.59
Lead	0.361
Nickel	0.17
Selenium	0.005
Silver	0.004
Zinc	1.51
Aluminum	2.73
Boron	0.23
Tin	0.417
Iron - Total	19.8
Iron - Dissolved	0.86
Phenols - Total	0.079
Chromium	0.007

M. L. Klusaritz

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September 29, 1989

Holiday Inn
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Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	9-19-89
Sample I.D.	:	133
Time Sampled	:	1450
Sampled By	:	Client
Date Received	:	9-20-89
Lab Sample No.	:	7376

RESULTS

Parameter	Result (mg/l)
Antimony	0.009
Arsenic	0.009
Beryllium	<0.001
Cadmium	0.0041
Copper	0.13
Lead	0.095
Nickel	0.023
Selenium	<0.003
Silver	0.002
Zinc	0.34
Aluminum	<0.02
Boron	0.14
Tin	0.009
Iron - Total	8.67
Iron - Dissolved	2.34
Phenols - Total	0.009
Chromium	0.011

M.L. Klusaritz
Michael L. Klusaritz
Laboratory Director

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AR001326

ORIGINAL (Red)

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October 24, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	9/27/89
Sample I.D.	:	135 - Solid
Time Sampled	:	1400
Sampled By	:	Client
Date Received	:	9/29/89
Lab Sample No.	:	8588

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	40.9
Cadmium	38.7
Chromium	11.4
Mercury	----
Silver	6.07
Lead	842.
Selenium	27.5
Copper	40.2
Nickel	29.6
Zinc	72.8
Thallium	1.06
Beryllium	2.35
Antimony	106.
Aluminum	3,950
Tin	20.5
Moisture Loss @ 105°C	<0.10 wt%

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ORIGINAL (Red)

October 6, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Water Analysis

Date Sampled	:	10/3/89
Sample I.D.	:	136 - Sump by Lagoon
Time Sampled	:	1000
Sampled By	:	Client
Date Received	:	10/3/89
Lab Sample No.	:	8547

RESULTS

Parameter	Results (mg/l)
Copper	0.030
Lead	1.20

M. L. Klusaritz

Michael L. Klusaritz
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October 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	137
Time Sampled	:	1700
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8846

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	10.3
Cadmium	0.81
Chromium	21.6
Mercury	----
Silver	<0.20
Lead	2150
Selenium	4.17
Copper	80.9
Nickel	1.35
Zinc	5.53
Thallium	0.27
Beryllium	<0.05
Antimony	9.44
Aluminum	2620
Tin	3.91
Moisture Loss @ 105°C	12.6

M. P. Klusaritz

Laboratory Director
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October 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	138
Time Sampled	:	1710
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8847

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	32.4
Cadmium	10.7
Chromium	9.20
Mercury	----
Silver	<0.20
Lead	19,300
Selenium	8.97
Copper	81.0
Nickel	16.6
Zinc	24.3
Thallium	0.41
Beryllium	<0.05
Antimony	72.2
Aluminum	5,450
Tin	31.3
Moisture Loss @ 105°C	12.4

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October 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	139
Time Sampled	:	1720
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8848

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	35.6
Cadmium	2.31
Chromium	51.3
Mercury	----
Silver	<0.20
Lead	15,600
Selenium	6.77
Copper	39.0
Nickel	8.97
Zinc	25.1
Thallium	0.30
Beryllium	<0.05
Antimony	60.8
Aluminum	3620
Tin	23.8
Moisture Loss @ 105°C	18.6

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October 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
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Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	140
Time Sampled	:	1730
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8849

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	8.94
Cadmium	0.72
Chromium	4.06
Mercury	----
Silver	<0.20
Lead	1030
Selenium	2.37
Copper	17.2
Nickel	5.97
Zinc	5.26
Thallium	0.19
Beryllium	<0.05
Antimony	1.55
Aluminum	841.
Tin	4.30
Moisture Loss @ 105°C	10.0

AR101332

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M. P. Kasa[illegible]
Laboratory Director

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October 10, 1989

Holiday Inn
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Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	141
Time Sampled	:	1740
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8850

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	11.0
Cadmium	1.01
Chromium	9.12
Mercury	----
Silver	<0.20
Lead	190.
Selenium	4.56
Copper	16.2
Nickel	19.9
Zinc	87.5
Thallium	0.11
Beryllium	<0.05
Antimony	5.98
Aluminum	5340
Tin	9.29
Moisture Loss @ 105°C	22.6

MAR 01333

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October 10, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/5/89
Sample I.D.	:	142
Time Sampled	:	1600
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8851

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	8.67
Cadmium	7.48
Chromium	4.91
Mercury	----
Silver	<0.20
Lead	660.
Selenium	3.11
Copper	30.9
Nickel	5.38
Zinc	35.5
Thallium	0.22
Beryllium	<0.05
Antimony	7.18
Aluminum	75.8
Tin	3.90
Moisture Loss @ 105°C	11.3

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- ORIGINAL (Red)

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October 23, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	143 - Clean Pool
Time Sampled	:	1500
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8870

RESULTS

Parameter	Result (mg/l)
Antimony	0.001
Arsenic	0.011
Beryllium	<0.005
Cadmium	<0.001
Copper	0.0024
Lead	0.0018
Nickel	0.006
Selenium	<0.003
Silver	0.002
Zinc	0.020
Aluminum	0.166
Boron	<0.10
Tin	0.002
Iron - Total	<0.005
Iron - Dissolved	<0.005
Phenols - Total	0.004
Chromium	0.005

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ORIGINAL (Red)

October 11, 1989

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Re: OHM Corporation
Route 309 North
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Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	144
Time Sampled	:	1515
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8871

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	19.1
Cadmium	0.59
Chromium	6.91
Mercury	----
Silver	0.33
Lead	153.
Selenium	7.28
Copper	16.8
Nickel	7.11
Zinc	21.3
Thallium	0.09
Beryllium	<0.05
Antimony	2.70
Aluminum	2,840
Tin	7.15
Moisture Loss @ 105°C	13.1 wt%

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Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	145
Time Sampled	:	1530
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8872

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	14.4
Cadmium	<0.10
Chromium	4.11
Mercury	----
Silver	<0.20
Lead	10.3
Selenium	2.57
Copper	12.1
Nickel	5.39
Zinc	18.2
Thallium	0.10
Beryllium	<0.05
Antimony	0.54
Aluminum	11,630
Tin	8.04
Moisture Loss @ 105°C	0.50 wt%

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Hess Environmental Laboratories.
Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

ORIGINAL (Red)

October 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	146
Time Sampled	:	1545
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8873

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	26.4
Cadmium	0.35
Chromium	7.39
Mercury	----
Silver	<0.20
Lead	9.67
Selenium	6.68
Copper	15.9
Nickel	7.71
Zinc	21.9
Thallium	0.07
Beryllium	<0.05
Antimony	0.91
Aluminum	3,190
Tin	4.69
Moisture Loss @ 105°C	16.3 wt%

M. L. Klus

Laboratory Director
HESS ENVIRONMENTAL LABORATORIES

MLK/gm

AR101338

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ORIGINAL (Red)

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Environmentalists and Laboratory Analysts.
304 Park Avenue. Stroudsburg. Pennsylvania 18360.
Telephone (717) 421-1550.

October 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	147
Time Sampled	:	1600
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8874

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	20.6
Cadmium	0.64
Chromium	6.36
Mercury	----
Silver	<0.20
Lead	18.7
Selenium	5.44
Copper	11.0
Nickel	7.21
Zinc	18.9
Thallium	0.10
Beryllium	<0.05
Antimony	0.35
Aluminum	2,200
Tin	3.33
Moisture Loss @ 105°C	12.5 wt%

AR101339

M. L. Kluz
Laboratory Director
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304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

October 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	148
Time Sampled	:	1610
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8875

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	20.5
Cadmium	2.08
Chromium	2.71
Mercury	----
Silver	<0.20
Lead	7.72
Selenium	4.34
Copper	14.0
Nickel	1.88
Zinc	9.60
Thallium	0.08
Beryllium	<0.05
Antimony	0.10
Aluminum	1,650
Tin	4.38
Moisture Loss @ 105°C	15.2 wt%

M. L. Kleist
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MLK/dm

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Hess Environmental Laboratories.
Environmentalists and Laboratory Analysts.
304 Park Avenue, Stroudsburg, Pennsylvania 18360.
Telephone (717) 421-1550.

October 11, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re: Solids Analysis

Date Sampled	:	10/6/89
Sample I.D.	:	149 - Backfill
Time Sampled	:	1330
Sampled By	:	Client
Date Received	:	10/6/89
Lab Sample No.	:	8879

RESULTS

Parameter	Results (mg/kg Dry Basis)
Arsenic	13.6
Cadmium	<0.20
Chromium	6.89
Mercury	----
Silver	<0.20
Lead	21.5
Selenium	1.98
Copper	26.9
Nickel	17.2
Zinc	51.0
Thallium	0.06
Beryllium	<0.05
Antimony	0.24
Aluminum	7,120
Tin	4.33
Moisture Loss @ 105°C	11.5 wt%

AR101341

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Phone (717) 421-1550, Fax (717) 421-6720

October 30, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galiota

Re: Water Analysis

Sample I.D.	Date & Time Sampled	Lead (mg/l)
150 - Background	10/19/89 @ 0935	0.44
151 - Storm Water Sump	10/19/89 @ 0920	1.83
152 - Crusher Bldg. Sump	10/19/89 @ 0900	3.22
153 - Dumping Area Sump	10/19/89 @ 0855	1.22
154 - Plastic Plant Sump	10/19/89 @ 0850	0.205
155 - Battery Chip Runoff	10/19/89 @ 0840	3.72
156 - Outlet to Creek	10/19/89 @ 0950	0.003

M. L. Klusaritz

Michael L. Klusaritz
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Phone (717) 421-1550, Fax (717) 421-6720

October 30, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re:

Date Sampled	:	10/19/89
Sample I.D.	:	157 - Culvert from Lagoon Area
Time Sampled	:	1000
Sampled By	:	Client
Date Received	:	10/20/89
Lab Sample No.	:	9277

RESULTS

Parameter	Result (mg/l)
Lead - Total	1.77
Lead - Dissolved	0.22
Copper - Total	0.069
Copper - Dissolved	0.007

M. L. Kline

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112 North Courtland Street P.O. Box 288, East Stroudsburg, Pennsylvania 18301
Phone (717) 421-1550, Fax (717) 421-8720

ORIGINAL (Red)

October 31, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Date Sampled	:	10/25/89
Sample I.D.	:	158 - Tank Water - Accumulated RAIN WATER
Time Sampled	:	1400
Sampled By	:	Client
Date Received	:	10/25/89
Lab Sample No.	:	9122

RESULTS

Parameter	Result (mg/l)	
Lead - Total	7.65	> 1.8 ug/l
Lead - Dissolved	7.46	
Copper - Total	0.10	> 10 ug/l
Copper - Dissolved	0.080	
Antimony ~~OK~~	0.24	> 160 ug/l
Arsenic OK	0.026	< 790 ug/l
Beryllium	0.009	> 5.5 ug/l
Cadmium	0.17	> 4.5 ug/l
Nickel OK	0.084	< 485 ug/l
Selenium OK	0.009	< 781 ug/l
Silver	0.004	> 3.1 ug/l
Zinc	0.28	> 30 ug/l
Aluminum OK	2.43	7820 ug/l
Boron OK	0.15	< 25.1 mg/l
~~Tin~~	0.26	
Iron - Total OK	1.88	< 22.5 mg/l
Iron - Dissolved	1.72	
Chromium OK	0.094	< 1035 ug/l

M.L. Klusaritz
Michael L. Klusaritz
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Phone (717) 421-1550, Fax (717) 421-6720

October 31, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: Joe Galioto

Re:

Date Sampled	:	10/26/89
Sample I.D.	:	159 - Tank Water
Time Sampled	:	1600
Sampled By	:	Client
Date Received	:	10/27/89
Lab Sample No.	:	9826

RESULTS

Parameter	Result (mg/l)
Lead - Total	3.46
Lead - Dissolved	3.16
Copper - Total	0.091
Copper - Dissolved	0.083

M. P. Kluck

Laboratory Director
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MLK/dm AR101345

ORIGINAL (Red)

Hess Environmental Laboratories
Environmentalists and Laboratory Analysts
112 North Courtland Street, P.O. Box 268, East Stroudsburg, Pennsylvania 18301
Phone (717) 421-1550, Fax (717) 421-6720

November 8, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	10/31/89
Sample I.D.	:	160 - Sump by Lagoon
Time Sampled	:	1500
Sampled By	:	Client
Date Received	:	11/2/89
Lab Sample No.	:	0290

RESULTS

Parameter	Result (mg/l)
Antimony	0.010
Beryllium	<0.005
Cadmium	0.040
Copper	0.042
Lead	2.05
Silver	0.0087
Zinc	0.094
Phenols - Total	0.006

M. L. Klusaritz
Michael L. Klusaritz
Laboratory Director
HESS ENVIRONMENTAL LABORATORIES

AR101346

ORIGINAL

Hess Environmental Laboratories
Environmentalists and Laboratory Analysts
112 North Courtland Street, P.O. Box 268, East Stroudsburg, Pennsylvania 18301
Phone (717) 421-1550, Fax (717) 421-6720

November 14, 1989

Holiday Inn
Re: OHM Corporation
Route 309 North
Hazelton, PA 18201-9601
Attn: J. Galioto

Re: Wastewater Analysis

Date Sampled	:	11/7/89
Sample I.D.	:	See Below
Time Sampled	:	1600
Sampled By	:	Client
Date Received	:	11/9/89
Lab Sample Nos.	:	0780 thru 0784

RESULTS

Sample I.D.	Lead	Copper	Cadmium	Zinc
162 (Filtered Tank H_2O)	3.26	0.40	0.061	0.75
163 (CO_3 Treatment)	0.10	0.008	0.007	0.023
164 (CO_3 & Caustic Treatment)	0.047	0.002	<0.001	0.017
165 (CO_3 & Scavanger Treatment)	0.004	0.002	0.0019	0.009
166 (Caustic & Scavanger Treatment)	0.002	0.003	<0.001	0.014

M. L. Klusaritz

Michael L. Klusaritz
Laboratory Director
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MLK/dm

ORIGINAL
(Red)

APPENDIX H

NEWSPAPER ARTICLES, PRESS RELEASES AND PUBLIC MEETING INFORMATION

N 4-28

REGION III INCIDENT NOTIFICATION REPORT

1. Case No.: PA87-48 ORIGINAL

2. Reported: (mm/dd/yy) 3-19-87	3. Time: 0800	Recorded By: J. SASEEN / ZICKLER	
4. ☐ Through NRC:	5. NRC Case No.:		

A. REPORTER

6. Reported By: PA DER Mr. MIESZKOWSKI

7. Organization Name:

8. Organization: ☐ 9. discharger ☐ 10. public ☐ 11. state ☐ 12. local ☐ 13. federal

14. Address:

15. City: | 16. County: | 17. State

18. Zip: | 19. Phone: ( )

B. DISCHARGER

20. ☐ As Above in A if 9 applies | 21. Name: TONOLLI CORP.

22. Address: Route 54 +

23. City: Nesquehoning | 24. County: CARBON. | 25. State PA

26. Zip: | 27. Phone: ( )

C. INCIDENT LOCATION

28. ☒ As Above in B | 29. Street or Approx. Location:

30. City: | 31. County: | 32. State

D. DATE

33. Spill Date: (mm/dd/yy) 3-19-87 - ON GOING. | 34. Spill Time:

E. MATERIAL

Material: ☐ Oil ☒ hazardous substance | 35. ☐ Material Unknown

Material	UN/DOT No	CAS No.	CHRIS Code	Quantity Spilled	Units (Circle 1)
36. LEAD ~~[illegible]~~	37.	38.	39.	40. N/A	41. lb. gal. bbl. oth
42. ARSENIC	43.	44.	45.	46. N/A	47. lb. gal. bbl. oth
48. CADMIUM CHROMIUM.	49.	50.	51.	52. N/A.	53. lb. gal. bbl. oth

F. SOURCE

Source of Spill: ☐ 54. highway ☐ 55. air transport ☐ 56. railway ☐ 57. vessel ☒ 58. fixed facility ☐ 59. pipeline ☐ 60. offshore ☐ Federal facility | 61. Vehicle ID or Carrier No.:

62. Description: ~~[illegible]~~ ABANDONED BATTERY RECYCLING SMELTING PLANT.

G. MED.

Medium Affected: ☐ 63. air ☐ 64. land ☒ 65. water ☐ drinking water ☒ 66. groundwater ☐ 67. within facility only ☐ none

68. Waterway Affected NESQUEHONING CREEK

H. CAUSE

Reported Cause: ☐ 69. transportation accident ☐ 70. equipment failure ☐ 71 operational error ☐ 72. natural phenomenon ☐ 73. dumping ☐ 74. unknown ☒ 75. other

76. Description: ABANDONED FACILITY

I. DAM

Damages: 77. no. of injuries ______ 78. no of deaths ______ ☐ 79. property damage > $50,000

J. ACTIONS

80. ☐ Evacuation | 81. Response Action Taken: EPA / TAT INVESTIGATION.

K. NOTIFIED

Caller Has Notified: ☐ 82. state/local ☐ 83. discharger ☐ 84. USCG ☒ 85. other ☐ 86. unknown

Agency Name EPA Reg III

L. COMMENTS

87. Comments site Assessment Conducted by TAT. upon Request by OSC. After Referral site made to EPA via PA. DER. for Continuing Investigation for poss. CERCLA Action.

☒ Additional Information

M. REGIONAL DATA FIELDS

Responsibility: ☒ EPA ☐ USCG ☐ Non-duty hours ☐ CWA 311 Spill letter

Response by: ☐ responsible party ☒ State ☐ local ☒ OSC ☒ other ☐ USCG

Agency Name: PA DER - EPA-OSC - TATs.

If OSC: Name ~~M. Zickler~~ J. Mason ☐ 311 Activation -- PIC # ☒ CERCLA Activation

EPA NOTIFICATION: Name, date, & time:

USCG: | WFO: SASEEN OSC

State/local: | EPA: [illegible]

OSC notified: | Referral:

AR101349

AR101349

Tonolli cuts spark rumors about closing

There are rumors circulating that the Tonolli Corporation plant along Route 54 near Nesquehoning might soon be closing.

Company officials were not available to discuss the matter, except for one spokesman to say, "We are operating and we will be open on Monday."

Several efforts to reach the management of Tonolli proved unsuccessful yesterday, but one individual who talked to the TIMES NEWS and preferred not to be identified said, "We're aware of the rumors and right now, we'll say that's all they are — rumors."

He said the rumors may have begun by the "large number" of layoffs the plant currently has. He couldn't say how many employees are laid off or what percentage of the labor team is without work other than "we have a lot of layoffs right now."

The spokesman couldn't comment on whether or not there is any expected call back for those laid off workers.

"We are operating now," said the spokesman. "We can only say that there are rumors."

He added, "If we were to close down, you would be among the first to be informed."

The lead-reclamation company, meanwhile, has applied to the Pennsylvania Department of Environmental Resources to close its existing hazardous waste facility, as required by the Pennsylvania Solid Waste Management Act of 1980. The closure plan, however, is pending DER approval.

e Times New

LEHIGHTON, PENNSYLVANIA, SATURDAY, SEPTEMBER 3[illegible]

THE TIMES-NEWS
LEHIGHTON PA
PM—13,750

Bales of plastic burn outside vacant Tonolli Plant

By RON GOWER and BOB URBAN, MANAGING EDITOR

A fire broke out in a pile of plastic on the premises of the vacant Tonolli Corporation's plant, on Rt. 54, in the Hauto section of Nesquehoning this morning.

Huge clouds of black, billowing smoke could be seen as far away as Summit Hill and Jim Thorpe.

The fire was discovered about 9 a.m., and immediately fire companies from surrounding communities were dispatched to the scene.

When in operation, the plant was a reclamation center for car and truck batteries.

The fire was brought under control in less than an hour and a half.

The blaze broke out in bales of plastic stored to the rear of a building that is in the process of being moved. The single, story building is going to be relocated at the Kovatch Truck Center, about a half mile from the Tonolli plant.

John "Sonny" Kovatch, president of the Kovatch Truck Center, said the fire never got inside the building. He said, "It was skids of junk plastic that was on fire. It was not an enclosed room."

He said his firm purchased the building from Baldwin Liquidators, which is in charge of the bankruptcy proceedings for the Tonolli Corporation. The building was not damaged by the fire.

Kovatch said the bales of plastic were stored on pallets. The fire did not reach large mounds of battery components which are stored on the firm's site.

Officials said a spark from a welding torch may have ignited the fire. Working in the area were employees of the Kovatch firm as well as a firm dismantling large pipes which a Pottsville Hospital has purchased.

Large trucks from KME, the Kovatch Mobile Equipment Company which manufactures fire apparatus, was credited with being key elements in bringing the fire under control so quickly. The fire was declared under control at about 10 a.m.

Responding to the scene in addition to equipment from KME were volunteers and trucks from Nesquehoning, Lansford, and Jim Thorpe. The Mahoning Township Volunteer Fire Company also

(Continued on Page 16, Col. 1)

DARK SMOKE pours from the vacant Tonolli Corporation plant, located on Route 54, west of Nesquehoning, this morning, as a Nesquehoning ambulance stands by in the event it is needed. (Ron Gower/TN)

•Bales of Plastic

(Continued from Page 1)

was summoned, but wasn't needed.

A security guard for Baldwin Liquidators refused to let reporters onto the premises.

Joseph Tout, chief of police in Nesquehoning, confirmed that the fire was contained to the pile of plastic.

There were no reported injuries.

Especially instrumental in combatting the fire were tank trucks. No fire hydrant water was on the site, since the plant was closed after declaring bankruptcy last year.

Harry Vadyak, chairman of the Lansford/Coaldale Joint Water Authority, explained that up until a year ago, the Authority provided private fire hydrant service for the Tonolli Plant.

But, when the company entered into bankruptcy proceedings, the Authority instructed its solicitor, Thomas McCready, to notify the company's federally-entrusted trustee, that water service was going to be discontinued.

"Since then no water has been at the plant," Vadyak explained this morning. "But when we heard about the fire today, I dispatched a worker to the site to turn on the hydrants again, so firefighters could have access to the water."

Efforts have been under way for some time for a cleanup of the Tonolli Corporation's hazardous waste site, since the operation was closed.

Public documents indicate that the company's lead-reclamation Groundwater Monitoring System Evaluation, conducted in 1985, failed to meet the standards of the U.S. Environmental Protection Agency (EPA).

The EPA documents show that Tonolli's solid waste landfill had contaminated groundwater "as evidenced by the elevated lead and arsenic levels in the downgradient wells."

This report was of major concern to the Lansford/Coaldale Joint Water Authority because those wells sit near the main source of water that services 9,000 customers in Lansford, Coaldale, Hauto and Lake Hauto.

When in operation, batteries of all sizes were brought to the plant on trucks and dumped to the rear of the building.

The House Energy and Commerce Committee had ordered those materials, sludge, acid and any other toxic material removed by Dec. 15, 1985. But that cleanup never occurred.

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fe. He didn't know
nati was, and he

ORIGINAL

EPA

(Continued from Page 2)

charging Tonolli with violating statutes in the Clean Streams, Solid Waste Management, Commonwealth Nuisance, Federal Nuisance, State Negligence and Federal Negligence acts.

Instead of naming every company that had been associated with Tonolli as a party in its suit, the authority limited its case to the parent company and its affiliates. EPA has taken an opposite stance, naming 36 PRPs it alleges helped contaminate the Hauto Valley land. Tonolli is a PRP but did not sign the consent agreement, EPA said.

When the company maintained operations, batteries of all sizes were brought to the plant on trucks and were dumped to the rear of the building. Acid from the batteries was allowed to flow into the ground, while batteries were subsequently taken indoors, crushed, placed in a large kiln and heated to a point where the lead was separated from the non-usable materials.

The waste materials were eventually stored in lagoons on the property. Although the lagoons are lined with rubber, the lining has torn, resulting in toxic materials infiltrating into the ground. On occasions, the lagoons also overflow after rainy periods, washing materials into nearby streams.

Contamination at the site was discovered by EPA between 1984 and 1987, when high elevations of lead, arsenic, chromium and cadmium were found during analyses of the soil and surface water.

Harold Yates, an EPA spokesman, said if left alone, the Tonolli site would eventually endanger nearby water supplies. EPA will concentrate on the half-million gallon lagoon containing the chemical wastes.

Currently, Superfund monies have been authorized to empty a storage tank filled with chemicals. The 500,000-gallon tank held a sulphuric acid solution from the batteries and contained traces of lead, chromium, arsenic, cadmium, zinc and nickel. The tank was reported to be leaking the solution to the environment.

In October, 1987, EPA announced $1.4 million was allocated from the federal Superfund to clean up the site.

Talks continue with 'generators'

Since 1980, Congress has appropriated more than $8 billion for removal of toxic and radioactive materials from contaminated sites under the Superfund program.

Earlier this month, a study by the Rand Corp. concluded the Superfund program has been "superslow" in dealing with the toxic waste dump problem and the EPA has not been aggressive enough in getting polluters to pay for the cleanup.

During the program's first eight years, cleanup was finished at only 34 of the 1,175 sites on the priority list at the time of the study, the Rand Corp. analysis said. The report also criticized the agency for not spending more of the money provided by Congress for cleanup.

In eight years, cleanup work has been completed on only about three dozen sites, and on Thursday, the EPA added 93 new properties in 32 states that need to be cleared of hazardous waste and debris.

The additional sites bring to 1,194 the waste dumps scheduled to be decontaminated under the Superfund program. EPA officials have said the program likely will cost tens of billions of dollars and take decades.

EPA Administrator William Reilly has acknowledged work has been completed at only a small number of Superfund sites, but maintains the number does not reflect the overall progress that has been made in the program.

Reilly recently announced plans to put greater emphasis on getting polluters to pay for cleanup projects through civil suits and a threat of penalties.

While EPA has consented to allow "generators" of the pollution materials to submit cleanup alternatives, the agency reserves the right to review and approve or disapprove the plans.

EPA pollution list includes area sites

Consent orders will delay remedial work

By Larry Neff and Bill O'Gurek
TIMES NEWS Writers

Two sites in the TIMES NEWS area have been added to the U.S. Environmental Protection Agency's National Priority List for cleanup operations, but in both cases, the federal agency has entered into consent orders to determine the responsibility of the parties whose operations have polluted the properties.

The former Eastern Diversified Metals property in Hometown, Rush Township, and the former Tonolli Corporation land in Hauto Valley, Nesquehoning, were named to the national priority list this week. The list represents the worst of an estimated 30,000 hazardous waste dumps in need of treatment nationwide.

The action this week, however, hardly means cleanup of the Diversified Metals and Tonolli properties will take place in the near future. Conversely, investigations are expected to last until 1991 before action on each property is likely to take place.

In June of 1988, the EPA began an intense probe of the Hometown site, searching for contamination and developing a cleanup plan. The agency entered into the consent order with the owner of the site, Theodore Sall, Inc., a subsidiary of Diversified Metals of Missouri, and with A.T. and T. Nassau Metals Corporation of South Carolin[illegible]

Similarly, EPA announced earlier this [illegible] it was party to a consent order with a gro[illegible] companies connected to the Tonolli op[illegible], which left, among other things, the groun[illegible]er in a contaminated state.

The consent orders mean EPA will allow the "potentially responsible parties" (PRPs) to develop a scope-and-solution study which would detail alternatives to remedy the sites. The bottom line is EPA will try to recover the cleanup costs from whoever was responsible for the pollution.

Diversified Metals

Records indicate Eastern Diversified Metals proceeded to dump approximately 157 million pounds of plastic wire insulation and copper and aluminum wire at the Hometown site between the late 1960s and 1977. The wastes were stockpiled in an open area to the rear of the plant site, comprising primarily polyvinyl and polyethylene chips.

In March, 1974, the Pennsylvania Department of Environmental Resources gave consent to the A.T. and T. Nassau Metals firm to institute on-site treatment of the plastic insulated wire. The firm constructed a water treatment plant, dug diversion ditches and installed a groundwater interceptor trench to control the surface groundwater runoff to and from the pile to the treatment plant and to treat the leachate.

During an investigation in April, 1984, the EPA collected samples of surface and underground water along with several soil samples. Results of the testing on the samples determined they contained heavy metals and organics, including cadmium, lead, benzene and chlorobenzene.

Almost 2,000 local residents in the area of the Diversified Metals plant depend on groundwater to drink.

Tonolli Corporation

The situation in the Nesquehoning Valley, where Tonolli conducted operations from 1974 to 198[illegible], [illegible] contamination of water supplies to over 10,000 people who are customers of the Lansford-Coaldale Joint Water Authority. The authority has a $20-million lawsuit against Tonolli and its entities pending in U.S. federal court in Scranton,

(See EPA on Page 2)

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(Red)

SATURDAY, SEPTEMBER 30, 1989 SINGLE COPY 30¢

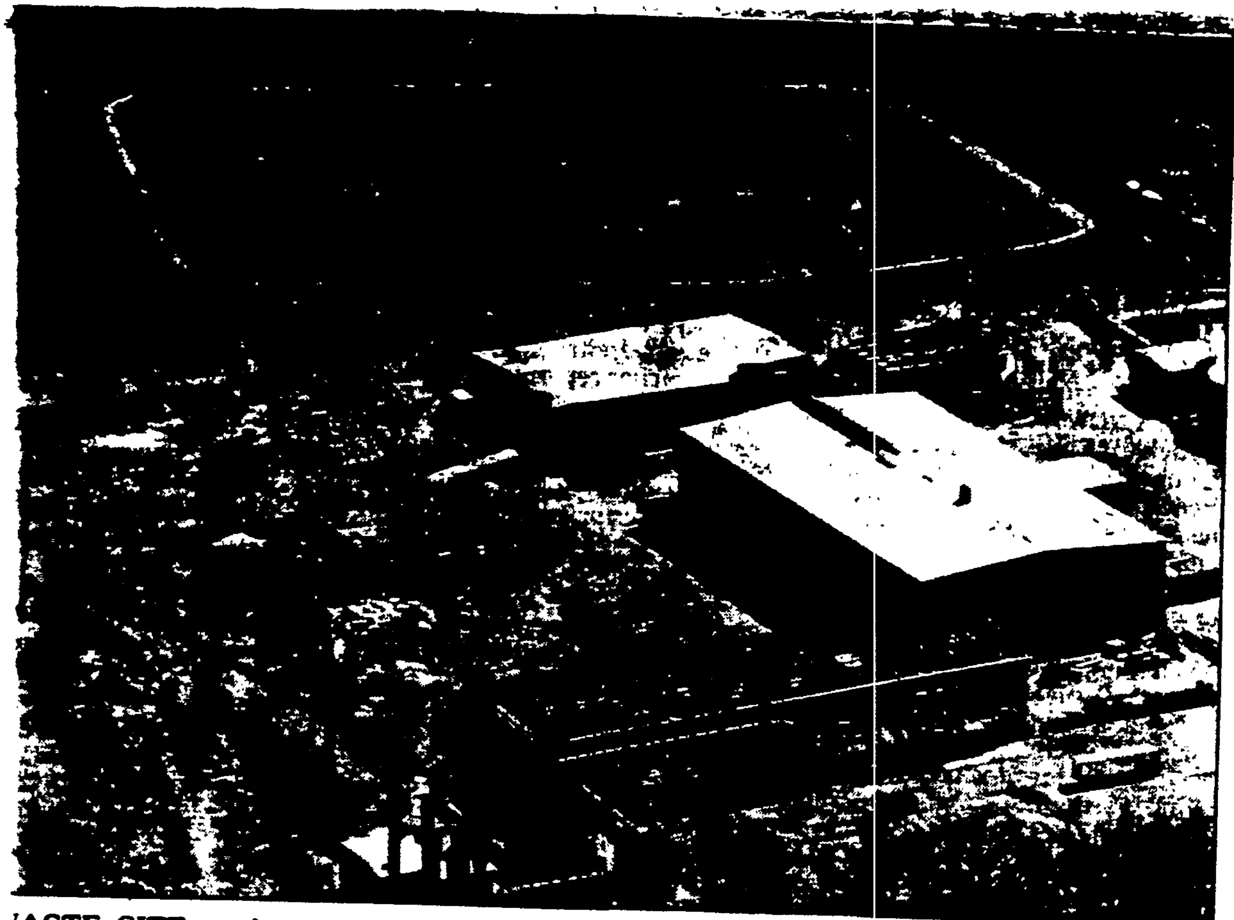
Fair fatality..................pg. 12
Spectator killed at Bloomsburg Fair

Bad News Bears.........pg. 13
Pleasant Valley keeps Tribe winless

The Times News

SERVING THE PEOPLE OF CARBON, SCHUYLKILL, LEHIGH, MONROE AND NORTHAMPTON COUNTIES

AR101355



/ASTE SITE — An aerial view of Tonolli Corporation land in Nesquehoning shows ounds of battery casings left exposed to weather, as well as a lagoon that holds con-minated waste. (Jeff Broadt/TIMES NEWS)

ORIGINAL (Red)

OCT 2 8 1987

Contact: Harold Yates
(215) 597-9825
Number and Date

EPA ALLOCATES $1.4 MILLION FOR TONOLLI SUPERFUND CLEANUP

PHILADELPHIA, PA--The U.S. Environmental Protection Agency has allocated $1.4 million from the Superfund for the removal of hazardous wastes at the Tonolli Corporation Recycling Site on route 54, two miles west of Nesquehoning, ~~Clairton~~ Carbon County, Pennsylvania.

From 1974 through 1985, the twenty acre site operated as a battery recycling and smelting facility. Processes performed at the site generated lead, cadmium, arsenic and chrome, which have contaminated on-site soil and surface water (rain water). Unrestricted access to the contaminated soil poses a direct contact health threat on-site. Contaminated surface water is migrating off the site, posing a threat to nearby drinking water supplies. Monitoring wells at the site confirm ground water contamination.

The major on-site contaminated areas are a 500,000 gallon lagoon used to store contaminated ~~surface~~ waste water running from the battery storage and crushing areas; a drainage trench which receives lagoon overflow; and a 500,000 gallon leaking storage tank, holding an acidic solution containing lead, cadmium, chromium, arsenic, zinc and nickel. There is also an on-site laboratory in a state of disrepair containing approximately 50 containers of acids, bases and other hazardous substances.

Exposure to lead poses the greatest health risks to the developing nervous system of children. Arsenic and cadmium are suspected carcinogens.

The $1.4 million Superfund dollars will be used to categorize, treat, remove and dispose of the contaminated materials; backfill the lagoon and trench areas; and repair the security fence. The cleanup is estimated at about 40 work days, not counting interruptions due to scheduling problems and the weather.

#D-19-16

AREA

EPA to study Tonolli site

By JIM DINO
Standard-Speaker Staff Writer

The federal goverment and a group of industries will study ways to clean up the former Tonolli Corp. Superfund site in Nesquehoning.

The federal Environmental Protection Agency (EPA) has entered into a consent order with a group of potentially responsible parties to conduct a remedial investigation and feasibility study into the former battery recycling plant, which was contaminated by materials from batteries that were crushed there.

The investigation and study will characterize the extent of contamination, and present available alternatives for remediation of the site, which may pose a long-term health risk to the public and environment and was proposed for inclusion on the National Priorities List. The contaminants of concern include lead, cadmium, chromium and arsenic.

The Tonolli Corp. operated on a 20-acre site along Route 54 in Nesquehoning from 1974 to 1985. Tonolli recycled lead batteries by crushing them to recover lead and plastic materials. In October, 1985, the firm filed for Chapter 11 bankruptcy. In January 1986, the case was converted to Chapter 7 liquidation proceedings.

At present, there is a lined landfill on the site, containing approximately 84,700 cubic yards of waste, and a surface impoundment for storing contaminated water from plant operations. Occasionally, liquid from the impoundment has found its way into the landfill. The wastewater contamination was discovered by EPA during sampling in 1984 and 1987.

In 1985, a consultant to Tonolli and the state Department of Environmental Resources (DER) detected arsenic and cadmium in on-site monitoring wells. An estimated 13,000 people obtain drinking water from the Lansford/Coaldale Joint Water Authority wells within three miles of the site.

Approximately 17,000 people live within a three-mile radius of the site, and rely on groundwater private wells as a drinking water source.

The work plan for the investigation and study will be submitted by the respondents. All work done by the respondents will be subject to EPA review and approval.

The potTntially responsible parties may be liable for contributing to the site's [illegible]tamination by arranging for the [illegible] treatment and disposal of the [illegible] teries which contained hazard[illegible] substances. The Tonolli Corp. is one [illegible] potentially responsible parties, but [illegible] participate in the negotiation [illegible] nor signed the order.

The potentially responsible part[illegible] Abrams Metal Co.; Alexandri[illegible] Allan Industries; Allied-Sinal (P[illegible] Anzon, Inc; Brandywine, Inc.; [illegible] American Corp.; Bundy Tubing [illegible] Charter Power System, Inc; Ciba Geigy Corp.; Coatesville Scrap Iron and Metal; Diamond State Salvage Co.; Douglas Battery Mfg. Co.; DuPont Co. (and Remington); East Penn Manufacturing Co. Inc.; Exide Corp.; Federated-Fry Metals; General Motors Corp. (Delco-Remy); [illegible]don Waste Co., Inc; Gould, Inc; Ham[illegible] Lead Products; Jacobson Metal Co.; Johnson Controls, Inc.; RSR Corp.; Richard B. Klaff; Metal Bank of America; Meyer-Saba Metals Co; New Castle Battery Mfg. Co.; New Castle Junk Co.; New Jersey Zinc Co.; Penn-Del Salvage; Roth Brothers Smelting Corp.; Shore Auto Wrecking; Simon Resources, Inc.; Simon-[illegible] Corp., and Wimco Metals, Inc.

AR101358

ORIGINAL (Red)

TO: RICH FETZER, OSC REGION III
AL PETERSON, OPA REGION III
DONNA McCARTNEY, RPM REGION III

FROM: CAROL MANNING, TAT REGION III

DATE: DECEMBER 8, 1989

SUBJECT: TONOLLI PUBLIC MEETING MINUTES
NESQUEHONING, CARBON COUNTY, PA

ON MONDAY EVENING NOVEMBER 20, 1989 A PUBLIC MEETING WAS HELD AT THE NESQUEHONING RECREATION CENTER FOR THE TONOLLI SUPERFUND SITE. EPA OSC FETZER AND OPA AL PETERSON DISCUSSED SARA/CERCLA, REMEDIAL, GROUNDWATER SAMPLING, FEASIBILITY STUDY, RECORD OF DECISION, AND THE TECHNICAL ASSISTANCE GRANT. A SLIDE PRESENTATION OF THE CLEAN-UP EVENTS AND ACTIVITIES THAT HAVE TAKEN PLACE AT THE TONOLLI SITE SINCE MAY 1989 FOLLOWED. UPON COMPLETION OF THE SLIDE PRESENTATION, A QUESTION/ANSWER PERIOD COMMENCED. THE FOLLOWING QUESTIONS/COMMENTS WERE OF CONCERN AND SHOULD BE ADDRESSED:

1. THE LANSFORD-COALDALE WATER AUTHORITY SAYS THAT THEIR WELLS ARE CONTAMINATED FROM TONOLLI. THE COGENERATION PLANT DEVELOPERS HAVE DRILLED ALL AROUND TONOLLI AND TESTED REGULARLY AND SAY THAT THERE IS NO GROUNDWATER CONTAMINATION OUTSIDE TONOLLI. WHICH IS CORRECT?

2. CAN EPA PREVENT ANOTHER COMPANY FROM STARTING UP BEFORE EPA CAN DETERMINE IF THE SURROUNDING AREA IS CONTAMINATED?

3. LARRY FOX, A FORMER EMPLOYEE OF TONOLLI STATED THAT HE USED TO PUMP ACID FROM THE LAGOON INTO THE LANDFILL.

4. DOES SOMEONE WHO PURCHASES A SUPERFUND SITE ASSUME RESPONSIBILITY FOR THE CLEAN-UP?

5. DOES BANKRUPTCY CREATE AN EASY WAY OUT FOR THE RESPONSIBLE PARTY?

6. HOW DID EPA GET INVOLVED IN THE TONOLLI SITE?

7. CULM BURNING/COGENERATING SITE- DOESN'T THERE HAVE TO BE A 300 FOOT BUFFER ZONE SINCE IT IS BORDERING A SUPERFUND SITE? CAN EPA PROVIDE RECOMMENDATIONS?

   JOE GUARDIANI
   35 E. CENTER ST.
   NESQUEHONING, PA 18240

   (NEEDS SPECIFICS ON WHAT THE PLANT CAN'T DO)

8. HOW SOON UNTIL SITE COMPLETION AT THE TONOLLI SITE?

ATTENTION

ENVIRONMENTAL ADVISORY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CONTACT: RICHARD M. FETZER
FEDERAL ON-SCENE COORDINATOR
(215) 597-9328

EPA SCHEDULES PUBLIC MEETING ON CLEANUP ACTIVITIES AT THE TONNOLI RECYCLING CORPORATION SUPERFUND SITE.

WHEN: NOVEMBER 20, 1989 (MONDAY)

TIME: 7:00 PM

WHERE: NESQUEHONING BOROUGH RECREATION CENTER
RAILROAD STREET
NESQUEHONING, PENNSYLVANIA

PURPOSE: THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) WILL HOLD A PUBLIC MEETING TO DISCUSS CLEANUP ACTIVITIES AT THE TONOLLI RECYCLING CORPORATION SUPERFUND SITE LOCATED ON ROUTE 54, NESQUEHONING, CARBON COUNTY, PENNSYLVANIA.

AGENDA:

- RECENT ACTIONS
- FUTURE ACTIONS
- FUTURE STUDIES
- QUESTION AND ANSWER PERIOD

ALL INTERESTED PARTIES ARE INVITED TO ATTEND.

ORIGINAL (Red)

27. WHAT IS CHAPTER 11 AND UNDER WHAT AUTHORITY WAS EQUIPMENT REMOVED FROM SITE?
ROBERT STIANCHE
BOX 112
RD #1
HAUTO, PA 18240

THE PUBLIC MEETING WAS ADJOURNED AT 2130 HOURS.

ORIGINAL (Red)

9. WHAT KIND OF DAMAGE HAS BEEN INCURRED AT THE TONOLLI SITE SO THEY CAN COMPARE IT TO THE COGERNERATING PLANT IF IT IS DEVELOPED?

10. WHERE DID TONOLLI INVESTIGATIONS BEGIN?

11. WHO IS FUNDING THE CLEAN-UP ACTIVITIES AND WHO ARE THE RESPONSIBLE PARTIES?

12. WHAT HAPPENS TO THE SLUDGE BEING STORED ON SITE?

13. IS BEAR CREEK CONTAMINATED?

14. WHAT WOULD HAPPEN IF THERE WAS A MAJOR FIRE ON SITE INCLUDING THE WASTE BEING STORED?

15. WHAT IS UNDERGROUND WATER CONTAMINATION?

16. IN THE US SUBCOMMITTEE HOUSE OF REPRESENTATIVES, AN APRIL 1985 STUDY OF RCRA FACILITIES, NPDES AND ENFORCEMENT, THERE IS NO FINAL NOTICE FOR TONOLLI. SINCE THIS IDENTIFIES GROUNDWATER CONTAMINATION, WHY WOULD IT GO TO PADER BEFORE A FEDERAL AGENCY?

17. WHAT WILL BE DONE TO THE LANDFILL AREA?

18. A FORMER EMPLOYEE OF TONOLLI STATED THAT THERE WERE TWO SMALLER LAGOONS (100 FEET DEEP) UNDER THE LANDFILL.

19. DUE TO THE CONTAMINATION OF SITE, WHAT ABOUT THE BUILDINGS AND MACHINERY THAT WERE MOVED OFF SITE? IS EPA ATTEMPTING TO TRACK THEM DOWN TO ANALYZE THEM FOR CONTAMINATION?
EDWARD McHUGH
42 E. CATAWISSA ST.
NESQUEHONING, PA 18240

20. HEAVY RAINS HAVE CAUSED BATTERY CASING CHIPS TO RUN INTO THE CREEK. WHAT IS EPA GOING TO DO ABOUT IT?

21. HOW COME ENVIRONMENTAL IMPACT STUDIES ARE NOT REQUIRED FOR NEW INDUSTRIES AND HOW CAN WE GO ABOUT HAVING IT DONE?

22. HOW DO WE ACCELERATE THE REMEDIAL INVESTIGATION?

23. IF THERE IS EVIDENCE THAT CONTAMINATION LEACHED OFF SITE, CAN EPA TEST OFF SITE?

24. FOR OTHER CONTRACTORS THAT ARE DRILLING AND MONITORING AROUND THE SITE, CAN EPA USE THEIR DATA?

25. WHEN WILL REMEDIAL ACTIVITIES BEGIN?

26. HOW ENVIRONMENTALLY UNSAFE IS TONOLLI?

APPENDIX I

SECURING BUILDINGS STORING HAZARDOUS MATERIALS

ORIGINAL (Red)

TO: RICH FETZER, OSC
JOE GALIOTO, ERCS RM

FROM: CHRIS ZWIEBEL, TAT

SUBJECT: SECURING ON-SITE BUILDINGS CONTAINING HAZARDOUS MATERIALS

DATE: OCTOBER 12, 1989

The following is a list of entrances to buildings on site which contain hazardous materials and therefore must be secured in order to reduce the possibility of exposure to anyone who may find their way into the building.

1. Personnel door on smelter/refinery building (building D), on the south wall of the building near the southeast corner of the building.
   --to be secured with a bar across the door, mounted by bolts into building wall.
   --door will be identified with an orange "1" on the door.

2. 15-foot door on the east side of building D is secure.
   --identified with "2."

2A. Personnel door in between doors 4 and 2 on building D. Door has been knocked out by lagoon sludge storage pile.
   --to be secured with plywood sheeting anchored to building.
   --identified as "2A."

3. Large door on flyash building.
   --to be secured with anchor bolts and chain link fence.
   --this building contains the highest levels of contaminants on site and should be the most secure.
   --identified with "3."

4. 15-foot door on east side of building D near the northeast corner of the building.
   --door itself is secure, but can be opened fairly easily. Door handle on south end of door is secured to wall with anchor bolts into adjacent wall and chain/lock.
   --identified with "4."

5. 2 doors; 1 personnel and 1 15-foot, located on north wall of building D.
   --personnel door to be blocked with concrete block lying adjacent to the door.
   --large door is to be chain link fence with anchor bolts.
   --identified as "5."

6. Hole the in wall between an addition to building D and building D.
   --to be secured with sheet metal of similar design to others found throughout the site. To be secured to the building with sheet metal screws.
   --identified as "6."

ORIGINAL (Red)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

DECEMBER 20, 1989

JOE GALIOTO
O.H. MATERIALS, INC.
WINDSOR, NJ

THE FOLLOWING ACTIVITIES REMAIN TO BE COMPLETED AT TONOLLI. PLEASE PLAN THESE ACTIVITIES WITH THE FIRST SCHEDULED TREATMENT SYSTEM MAINTAINENCE.

1> OPW AND VALVE TO BE ATTACHED TO OVERFLOW FROM 500K GALLON STORAGE TANK. ALSO, HAVE HOSING STORED AT A CONVIENT ACCESS POINT, AND MARKED SO IT COULD BE UTILIZED EASILY DURING A HEAVY RAINFALL.

2> BUILDING "D" SECURITY. DOOR 2A, NOT SECURED PROPERLY. CHAIN SHOULD BE FASTENED TO THE PLYWOOD. THE PLYWOOD CAN BE REMOVED TOO EASILY. DOOR 6, NOT FASTENED PROPERLY. SUGGEST SHEET METAL SCREWS OR POP RIVETS.

3> CONSTRUCT BOX FOR PROTECTING ELECTRICAL PANELS ADJACENT TO WATER TREATMENT BUILDING. PRIORITY!

4> FINISH GRADING, TOPSOIL AND SEED EXCAVATED DRAINAGE DITCH AREA. THIS CAN WAIT UNTIL WARM WEATHER WARM WEATHER.

5> PUT A DOOR WITH HINGES, LATCH AND A LOCK ON STORMWATER SUMP BUILDING.

6> SEND ME A COPY OF ALL BLOOD LEAD ANALYSES PERFORMED ON ALL OHM EMPLOYEES WHO HAVE EVER WORKED ON THIS SITE.

7> INSTALL MARKERS ON WATER SYSTEM DRAINAGE PIPE CAPABLE OF SHOWING LOCATION OF PIPE AFTER GRASSES IN FORMER LAGOON AREA GROW OVER THE PIPE.

8> POST SIGNS CLEARLY SHOWING THAT A HAZARD/HAZARDOUS MATERIAL EXISTS WITH IN SITE PROPERTY. THESE ARE TO BE POSTED ON STAKES JUST INSIDE THE SITE FENCE AROUND THE PERIMETER AS WELL AS THE ACCESS AREAS TO BUILDING "D", THE FLY ASH BUILDING, FORMER LAGOON AREA, STORMWATER SUMP, WATER TREATMENT BUILDING, AND THE TONOLLI OFFICE BUILDING.

I EXPECT THE SYSTEM TO BE CHECKED EACH MONTH BEGINNING IN JANUARY 1990. I WOULD LIKE BOTH THE TAT AND I INFORMED AT LEAST 120 HOURS IN ADVANCE BEFORE THE MAINTENANCE TRIP.

RICHARD M. FETZER, OSC
USEPA REGION III
PHILADELPHIA, PA

ORIGINAL (Red)

7. Personnel door connecting lab with building D.
--to be secured with a piece of plywood attached to concrete wall adjacent to the door.
--identified as "7."

8. 15-foot door on west side of building D.
--to be secured with chain link fence attached to concrete wall and I-beam on both sides of the door.
--identified as "8."

9. Hole in site fence at the location of the background sample.
--marked with orange paint.

APPENDIX J

RANDOM SAMPLING FOR METALS
BENEATH THE LAGOON LINER

ORIGINAL (Red)

WESTON MANAGERS DESIGNERS/CONSULTANTS 53 Haddonfield Road, Suite 306, Cherry Hill, NJ 08002
(609) 482-0222 • FAX (609) 482-6788

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE REMOVAL AND PREVENTION
EPA CONTRACT 68-01-7367

MEMORANDUM

TO: Rich Fetzer, OSC, EPA Region III
Eastern Response Section

THRU: Mike Zickler, TATL, Region III MZ — TDD #8910-10, PCS #2693

THRU: Bhupi Khona, RSO, Region III

FROM: S. Andrew Sochanski, TAT Region III

SUBJECT: Tonolli Site
Random Sampling for Metals
Beneath the Onsite Lagoon Liner

DATE: October 17, 1989

INTRODUCTION

A random sampling procedure was instituted to determine the extent and degree of subsurface (soil/sediment) contamination beneath the onsite lagoon liner at the Tonolli CERCLA Removal Site, Nesquehoning, Carbon County, Pennsylvania. The liner of the lagoon was in a poor condition and therefore, subsurface contamination was expected.

The objective of a random sampling plan is to collect a sufficient number of samples that represent the chemical contamination (wastes) precisely and accurately. Sampling accuracy is based upon the statistical measurement of the mean ($\bar{X}$), dispersion or standard deviation (S), variance of the sample (S^2), the standard error ($S_{\bar{X}}$) and the Confidence Interval (CI). When these statistical requirements are determined to be accurate, the upper limit of the

AR101368

ORIGINAL (Red)

STATISTICAL REQUIREMENTS FOR A RANDOM SAMPLING PLAN

X - Endrin variable of concentration

X_i - Individual measurement

RT - Regulatory Threshold for lead (500 ppm)

$\overline{X}$ - Mean measurements generated by the sample results.

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Where n = number of sample measurements

Sample Variance

$$S^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)\ 2/n}{n-1}$$

$$S = \sqrt{S^2}$$

$$S_{\overline{X}} = \frac{S}{\sqrt{n}}$$

$$n = \frac{t^2\ .20\ S^2}{\Delta^2} \qquad \Delta = RT - \overline{X}$$

STATISTICAL ANALYTICAL RESULTS

CASE 1: Lead concentration in the soil/sediments beneath the liner of the lagoon.

$\overline{X}$ = 7,748 ppm (lead) - mean value for the five random results.

$\overline{X} \geq$ RT (500 ppm) Therefore, a hazard is present due to the contaminated material (sediments/soils).

Sample Variance - is calculated to determine the appropriate number of samples to validate the analytical.

$S^2 = 7.5 \times 10^7$

$S = \sqrt{S^2} = 8661$

$S_{\overline{X}} = \frac{S}{\sqrt{n}} = 3,873.5$

CI is compared to the Regulatory Threshold (RT) for each contaminant of concern. When the upper limit of the CI is less than the regulatory threshold, the contaminant is considered not to be present at a hazardous level and the study is complete (See Sampling of Solid Wastes, EPA SW-846).

BACKGROUND

The random sampling procedure was adopted to determine the degree and extent of the contamination beneath the lagoon liner. Initially five random sample locations were selected beneath the liner of the onsite lagoon. The result of the random sampling was statistically checked for variance and mean calculations to validate the initial sampling.

A sampling flow chart was developed with the following criteria. If two of the five random sample locations had concentrations of lead which were greater than 500 parts per million (ppm), excavation was necessary to remove the contaminated soil/sediments. Furthermore, if the average contamination for lead was greater than or equal to 2,000 ppm, excavation would also be necessary (See Tonolli Sampling Flow Chart).

ANALYTICAL RESULTS

CASE 1: Subsurface soil/sediments beneath the onsite lagoon liner.

Sample Number	Lead (ppm)
#137	2,150
#138	19,300
#139	15,600
#140	1,030
#142	660
#141 (Background)	190

CASE 2: Clay layer beneath the onsite lagoon at a depth of two to four inches into the clay liner.

Sample Number	Lead (ppm)
#144	153
#145	10.3
#146	9.67
#147	18.7
#148	7.72
#141 (Background)	190

ORIGINAL (Red)

LLI Sample No. AQ 1434014

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

TN01 37 mm Filter Tonolli
Bldg D 35' from West Wall 18' from South Wall
Sampled 9/1/89 (1602) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	26.	ug	2.	040101300S
Lead Duplicate	28.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101376

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. AQ 1434021

ORIGIN. (Red.

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN Blank 37 mm Filter Tonolli

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	< 2.	ug	2.	040101300S
Lead Duplicate	< 2.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ORIGINAL (Red)

APPENDIX G

REGION III INCIDENT NOTIFICATION REPORT

ORIGINAL (Red)

DELIVERY ORDER FOR EMERGENCY RESPONSE CLEANUP SERVICES

ORIGINAL (Red)

(This delivery order is issued subject to all terms and conditions of the contract identified in Block 2.)

1. DATE OF ORDER	2. CONTRACT NUMBER	3. ORDER NUMBER
10-13-87	68-01-7445	744503014

4. TIME OF INITIAL ORDER *(If initial order was verbal) (Specify Time Zone)*

1400 est ☐ AM ☒ PM

5. DELIVERY ORDER CEILING AMOUNT *(Obligated Amount)*

$100,000

6. ACCOUNTING AND APPROPRIATION DATA

Appropriation Number	Document Control No.	Account Number	Object Class
68/20/8145	KV 0010	8TFA3ASE16	[illegible]

7a. ISSUED TO: CONTRACTOR *(Name, Address, and ZIP Code)*

OH Materials Company
16406 US Route 224 East
Findlay, OH 45839

8a. ISSUED BY: ORDERING OFFICE *(Name, Address, and ZIP Code)*

US Environmental Protection Agency
Region III
303 Methodist Building
Wheeling, WV 26003

7b. PROGRAM MANAGER *(Name and Phone Number)*

John Co[illegible]us, (800)336-4508

8b. EPA REGION/USCG DISTRICT

Region III

8c. ZONE

1

7c. RESPONSE MANAGER *(Name and Phone Number)*

8d. ON-SCENE COORDINATOR *(Name and Phone Number)*

Jerry Saseen ([illegible])[illegible]-9831

9. RESPONSE LOCATION *(Site Name and/or Address and ZIP Code)*

Tonolli Corp. Site
Nesquehoning, Carbon Co. Pa.

10. CONTRACTOR REQUIRED ON SITE *(Date and Time) (Specify Time Zone)*

10-19-87 1400 est ☐ AM ☐ PM

11. REQUIRED WORK COMPLETION DATE

10-19-88

12. STATEMENT OF WORK

The Contractor shall furnish the necessary personnel, materials, services, facilities, and otherwise do all things necessary for or incident to the performance of the work set forth below:

Response manager to mobilize to the site October 19, 1987 to set site work schedule, with the on scene co-ordinator. Upon notification of the OSC, mobilize crews to the site to initiate cleanup.

13. ORDERING OFFICER

NAME/TITLE	SIGNATURE	DATE
On-Scene Coordinator	[signature]	10-13-87

ORDERING OFFICER/OSC

AR101374

EPA Form 1900-59 (11-83) ☆ U.S. GPO 1983—426-222/364

AR101374

ORIGINAL (Red)

APPENDIX F

DELIVERY ORDER

ANALYSIS REPOR

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
Matrix Spike Dup. of Blank Wipe Sample 091889TNWOD

ORIGINAL (Red)

Date Reported 9/26/8
Date Submitted 9/21/8
Discard Date 10/27/8
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB
Lead		see below		0401(
Spike recovery	106.	%		

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories
Reviewed and Approved

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101376

Jack T. Follweiler,
Group Ldr., Industr

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNWOD Blank Wipe Sample Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 10.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

The American Association for Laboratory Accreditation Chemical, Biological & Environmental fields of testing.

Member: American Council of Independent Laboratories, Inc.

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101377

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:
Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

[illegible] Pike, Lancaster, PA 17601-5994 (717) 656-[illegible]

[illegible] Sample No. [illegible]

ORIGINAL (Red)

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
Matrix Spike of Blank Wipe Sample 091889TNWOD

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead		see below		040101300S*
Spike recovery	100.	%		

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

AR101378

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follveiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW03 Wipe Sample Entrance Wall Near
Receptionist Window 9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	1,130.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

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Member: American Council of Independent Laboratories, Inc.

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
033 03182 13.00 002600

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AR101379

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW04 Wipe Sample Lunch Room Proposed Wall
Near Window 9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	190.	ug	10.	040101300S*

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Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW01 Wipe Sample Proposed Lunch Room Floor
9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	27,100.	ug	10.	040101300S*

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Reviewed and Approved by:
Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

ORIGINAL

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW02 Wipe Sample Entrance Floor
9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	43,100.	ug	10.	040101300S*

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ANALYSIS REPORT

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020 D 1 13

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN04 37 mm Filter Bange Tonolli
9/18/89
382 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	6.	ug	2.	040101300S*
Lead Confirmation	5.	ug	2.	900101300S
Lead in Air	8.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

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Jack T. Follveiler, B.S.
Group Ldr., Industrial Hygiene

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

ORIGINAL (Red)

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

091889TN05 37 mm Filter RT Hall Personal Tonolli
9/18/89
97 min @ 2 lpm

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	3.	ug	2.	040101300S*
Lead Confirmation	3.	ug	2.	900101300S
Lead in Air	15.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

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Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

091889TN02 37 mm Filter Filter Press Tonolli
9/18/89
402 min @ 2 lpm

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 2.	ug	2.	040101300S*
Lead Confirmation	< 2.	ug	2.	900101300S
Lead in Air	< 2.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

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Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN03 37 mm Filter Mixing Tank Tonolli
9/18/89
386 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	3.	ug	2.	040101300S*
Lead Confirmation	3.	ug	2.	900101300S
Lead in Air	4.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN00 37 mm Filter BLANK Tonolli
9/18/89

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 2.	ug	2.	040101300S*
Lead Confirmation	< 2.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

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Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

ORIGINAL [illegible]

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN01 37 mm Filter Command Post Tonolli
9/18/89
394 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	4.	ug	2.	040101300S*
Lead Confirmation	4.	ug	2.	900101300S
Lead in Air	5.	ug/m3		900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

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Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

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AR101388

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

[illegible] Pike, Lancaster, PA 1760 [illegible] (717) 656-2301

LLI Sample No. AQ 1434019

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN06 37 mm Filter Tonolli
Personal Air Sampling Attached RT
Sampled 9/1/89 (1545) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	9.	ug	2.	040101300S
Lead Duplicate	10.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

American Association for Laboratory Accreditation Chemical, Biological & Environmental fields of testing

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

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Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101389

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

ORIGINAL

LLI Sample No. AQ 1434020

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN07 37 mm Filter Tonolli
Mud/Mix Tank Adj. to Lagoon
Sampled 9/1/89 (1525) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	180.	ug	2.	040101300S
Lead Duplicate	204.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

AR101390

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
080 03182 -13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Kohlweiler, B.S.
Group Ldr., Industrial Hygiene

AR101390

LLI Sample No. AQ 1434017

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN04 37 mm Filter Tonolli
Front Loader Cabin Upper Left Corner
Sampled 9/1/89 (1515) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	19.	ug	2.	040101300S
Lead Duplicate	21.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

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Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follveiler, B.S.
Group Ldr., Industrial Hygiene

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Lancaster Laboratories INCORPORATED

LLI Sample No. AQ 1434018

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN05 37 mm Filter Tonolli
Air Conditioner on West Side of Corner Post
Sampled 9/1/89 (1508) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	3.	ug	2.	040101300S
Lead Duplicate	3.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101392

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

LLI Sample No. AQ 1434015

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

TN02 37 mm Filter Tonolli
1/2' from West Wall 25' from South Wall Bldg D
Sampled 9/1/89 (1556) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	60.	ug	2.	040101300S
Lead Duplicate	63.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
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Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Fritzweiler, B.S.
Group Ldr., Industrial Hygiene

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ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 • (717) 656-2301

ORIGINAL (Red)

LLI Sample No. AQ 1434016

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN03 37 mm Filter Tonolli
75' from West Wall 50' from South Wall Bldg D
Sampled 9/1/89 (1605) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	25.	ug	2.	040101300S
Lead Duplicate	27.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

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AR101394

In CASE 1, n = 3.35 the number of required samples to show that a hazard is present in the sediments beneath the liner of the lagoon. Therefore, the minimum number of samples that are required to characterize the contamination beneath the lagoon liner is four (n=3.35). Then, four samples are the least number of samples to be collected to sufficently estimate the true mean (u) concentration for lead.

CASE 2: Lead contamination in the clay liner beneath the soil/sediments in case 1.

$\bar{X}$ = 39.87 ppm (lead)

$\bar{X} \leq$ RT (500 ppm) No hazard is present

Sample Variance

$S^2 = 3966.8$

$S = \sqrt{S^2} = 62.98$

$S_{\bar{X}} = \frac{S}{\sqrt{n}} = 28.16$

$\bar{X}$ is less than S^2

39.87 < 3966.0 (negative binomial distribution)

Conclusion

The random sampling plan developed for the Tonolli Removal Site generated adequate data to determine the extent and depth to which lead contamination existed beneath the liner of the lagoon. In Case 1, the mean value $\bar{X}$ is 7,748 ppm which is greater than the regulatory threshold (500 ppm for lead). The calculated confidence interval (CI) is 7,748 ppm ± (5,938). Since both values of CI are greater than the regulatory threshold, it is confident that lead contamination is present.

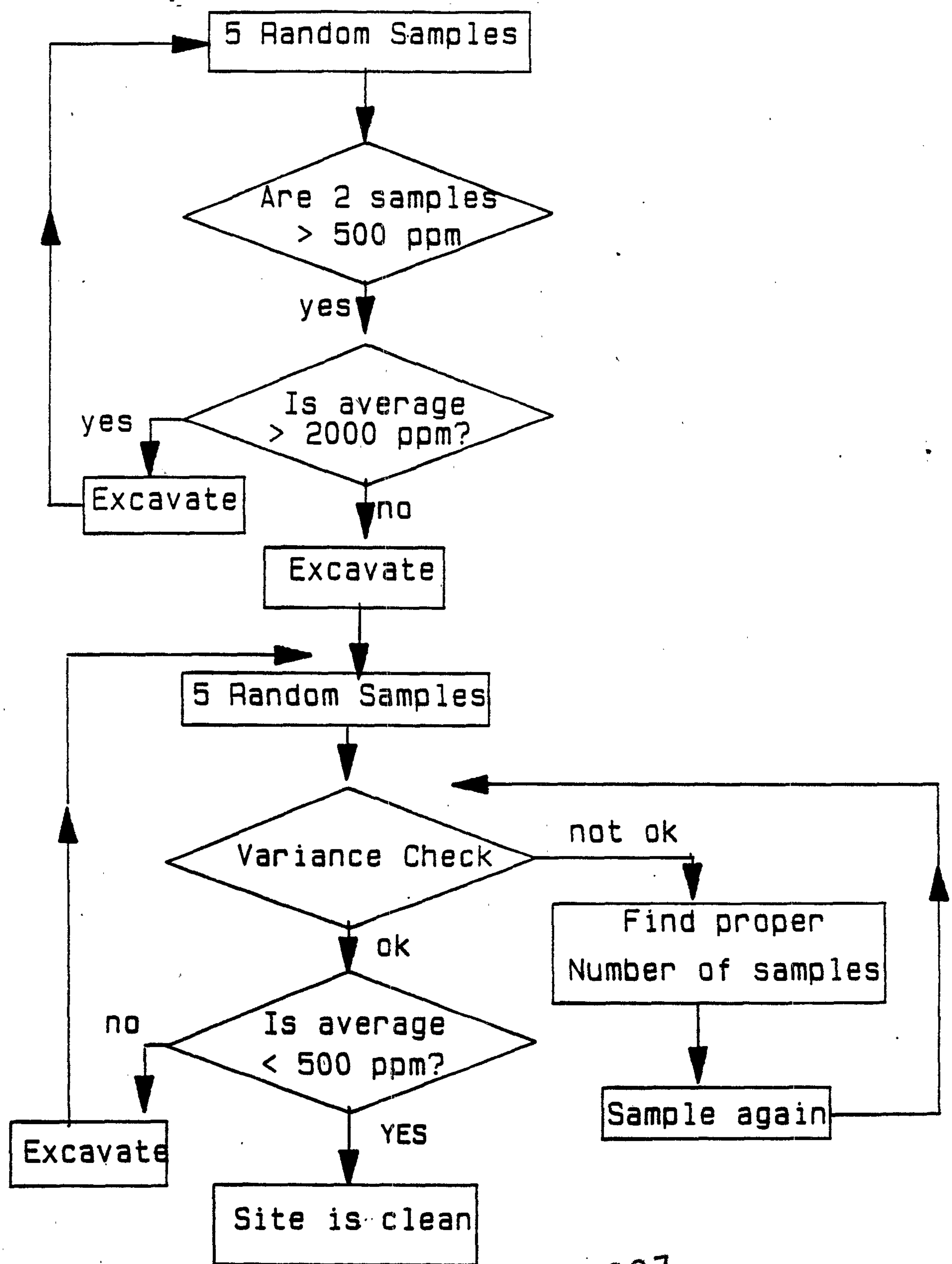
In Case 2 (clay layer), the mean value $\bar{X}$ is 39.87 ppm which is less than the regulatory threshold (500 ppm for lead). This suggests that no lead contamination exists at a hazardous concentration in the clay layer. To further validate the analytical results, the confidence interval (CI) is calculated. In Case 2, the CI is equal to 39.87 ± 43.45 ppm of lead. Both values for CI (-3.29 or 83.32) are less than the regulatory threshold and it can be stated that the amount of lead contamination in the clay layer is considered to be below the hazardous concentration level.

The clay layer was found to be not contaminated at a hazardous level for lead, although the material (sediments/soil) that was above the clay layer was found to be contaminated (greater than 500 ppm concentration of lead). Therefore, excavation was necessary to remove the contaminated material (sediment/soils) just to the depth of the clay layer beneath the onsite lagoon.

AS/tl

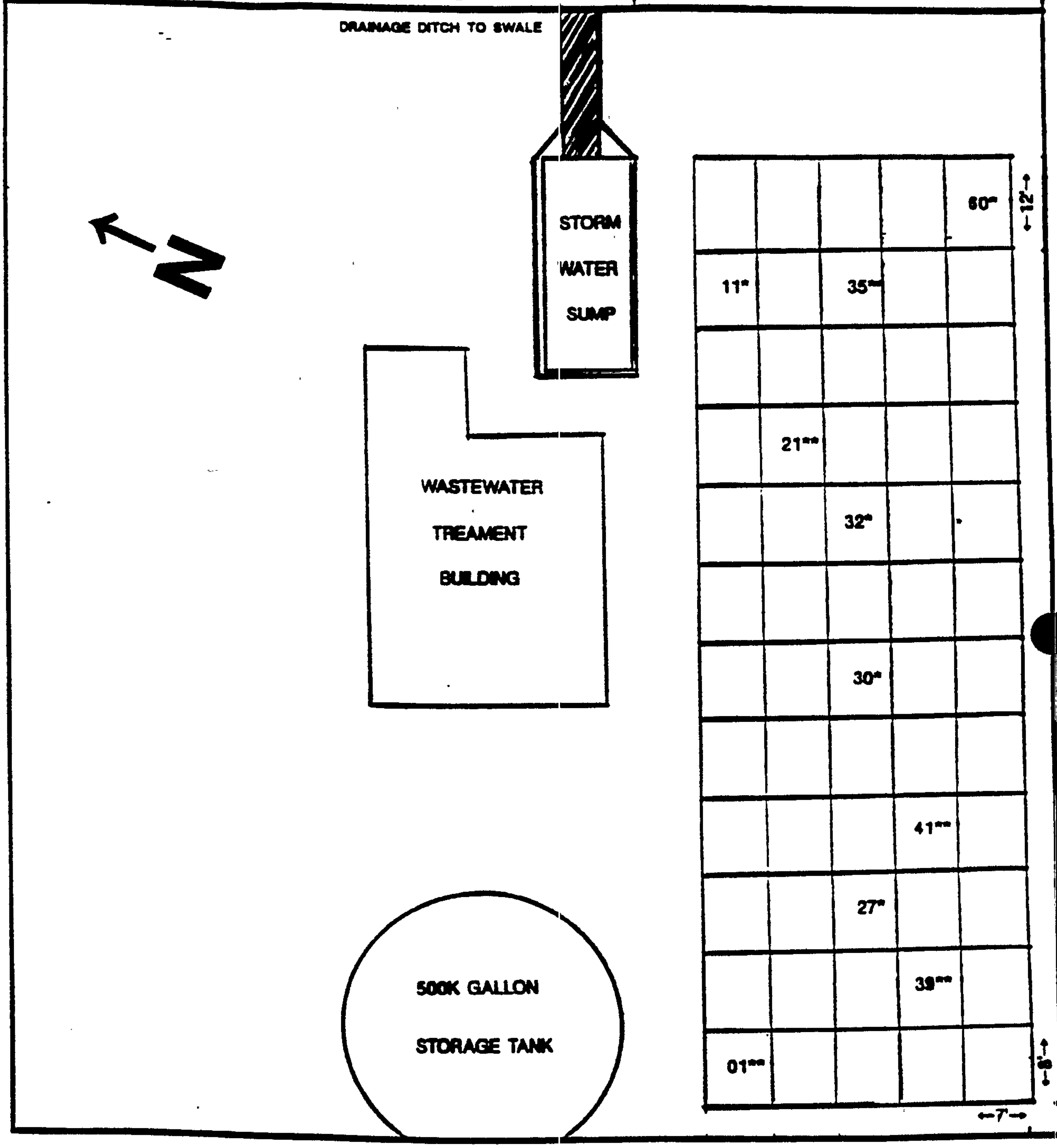
Enclosures: Tonolli Sampling Flow Chart - 1 page
Tonolli Site Random Sample Locations - 1 page
Sampling of Solid Waste - 26 pages

TONOLLI SAMPLING FLOW CHART



WESTON·SPER

TDD Number: 8910-10A
PCS Number: 2776



LAGOON BOTTOM DIMENSIONS 35' x 100'
★ NOT TO SCALE ★

* = 10/05/89 SAMPLING
** = 10/06/89 SAMPLING

LAGOON RANDOM SAMPLING LOCATIONS

TONOLLI CORPORATION SITE

NESQUEHONING, CARBON COUNTY, PENNSYLVANIA

AR101398

11/07/89

TEST METHODS FOR EVALUATING SOLID WASTE

—Physical/Chemical Methods—

SW-846

Second Edition

Revised

U.S. ENVIRONMENTAL PROTECTION AGENCY

APRIL 1984

TEST METHODS FOR EVALUATING SOLID WASTE

—Physical/Chemical Methods—

- Instructions for Replacement Pages, April 1984 revision -

The enclosed are replacement pages for TEST METHODS FOR EVALUATING SOLID WASTE - PHYSICAL AND CHEMICAL METHODS. Sides of the page where revisions have been made are marked "Revised 4/84".

Methods are arranged in the manual in numerical order and are paginated within each method. No individual page number refers to placement in the book as a whole. That is, "5030 / 3" on the top of a page indicates that page is page 3 of Method 5030.

Text pages are divided into sections using the weighted decimal point system. Page numbers refer to that page within a particular section.

Replace old copies of pages with the new updated ones.

PREFACE

This second edition of "Test Methods for Evaluating Solid Waste" contains the procedures that may be used by the regulated community or others in order to determine whether a waste is a hazardous waste as defined by regulations promulgated under Section 3001 of the Resource Conservation and Recovery Act (RCRA, PL 94-580 (40 CFR Part 261). The manual provides methodology for collecting representative samples of the waste, and for determining the ignitability, corrosivity, reactivity, Extraction Procedure (EP) Toxicity and composition of the waste.

This document has been developed to:

a. provide methods which will be acceptable to the Agency when used by the regulated community to support waste evaluations and listing and delisting petitions, and

b. describe the methods that will be used by the Agency in conducting investigations under Section 3001, 3007, and 3008.

The practice of evaluating solid wastes for environmental and human health hazards is new. Experience has only recently accumulated in analyzing wastes for inorganic and organic species, and for intrinsic properties such as pH, flash point, reactivity and leachability. This manual will serve as a compilation of state-of-the-art methodology for conducting such tests. It is meant to be a dynamic document. The methodology descriptions will be frequently updated and expanded in order to keep pace with the developments being achieved by EPA, the regulated community, and others.

Standardized approved methods must be available so that the regulated community can be certain that the data it provides will be acceptable to the Agency. This manual thus makes available to the regulated community and others, those methods that the Agency considers suitable.

Many of the methods presented in this manual have not been fully evaluated by the Agency using materials characteristic of the wastes regulated under RCRA. Such evaluations are underway. However, until such time as the methods in this manual are superseded, the Agency will accept data obtained by the test methods presented in this manual. Only those data that are obtained when Quality Control and Quality Assurance procedures are followed by the testing organization will be accepted by the Agency.

This manual will eventually include a second part comprised of biological methods for determining toxic properties of RCRA wastes. Such toxic properties may include carcinogenicity, mutagenicity, teratogenicity, aquatic toxicity, phytotoxicity, and mammalian toxicity.

Methods will be provided in this present volume for the following specific areas:

a. design of sampling and evaluation plans;

b. collection of samples from various types of environments (e.g., pipes, drums, pits, ponds, piles, tanks);

c. transportation and storage of samples;

d. chain-of custody considerations to insure defensibility of data;

e. determination of the pH, corrosivity to steel, flash point, and explosivity;

f. conduct of the Extraction Procedure;

g. analysis of wastes and extracts for organic and inorganic constituents;

h. safety in solid waste sampling and testing, and

i. quality control and quality assurance.

The analytical and sampling methods presented in this manual have been derived from a number of published sources, chiefly:

a. "Methods for the Evaluation of Water and Wastewater," EPA-600/4-79-020, U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268,

b. "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water an Wastewater," U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268, September 1978,

c. Guidelines Establishing Test Procedures for the Analysis of Pollutants; Proposed Regulations; 44 FR 69464-69575, and

d. "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA-600/2-80-018, U.S. EPA, Municipal Environmental Research Laboratory, Cincinnati, OH 45268.

In addition, work conducted by and the assistance of scientists of the Environmental Monitoring Systems Laboratory at Las Vegas, NV, the Environmental Research Laboratory at Athens, GA, and the National Enforcement Investigations Center at Denver, CO, is gratefully acknowledged and appreciated.

Although a sincere effort has been made to select methods that are applicable to the widest range of expected wastes, significant interferences, or other problems, may be encountered with certain samples. In these situations, the analyst is advised to contact the Manager, Waste Analysis Program (WH-565), Waste Characterization Branch, Office of Solid Waste, Washington, D.C. 20460 (202-755-9187) for assistance. The manual is intended to serve all those with a need to evaluate solid waste. Your comments, corrections, suggestions, and questions concerning any material contained in, or omitted from, this manual will be gratefully appreciated. Please direct your comments to the above address.

ORIGINAL (Red)

TABLE OF CONTENTS[1]

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[1]Section and method numbers from the first edition of this manual are given in brackets, and are also listed in the Conversion Table following this Table of Contents.

[2]To ensure that future additions and deletions of material can be made without disruption, the manual's pages are not numbered sequentially. Section numbers are given with the page number. Actual methods are numbered sequentially within themselves. Revised pages are noted as such in the bottom corner of the page.

SECTION/METHOD

SECTION SEVEN INORGANIC ANALYTICAL METHODS (Continued)

ORIGINAL (Red)

ACKNOWLEDGMENT

The Office of Solid Waste would like especially to thank the following individuals and groups for the help and advice they gave us during the preparation of this manual:

U.S. Environmental Protection Agency, Inductively Coupled Plasma Users Group

Dr. Theodore Martin and Dr. Gerald McKey, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio

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We would also like to thank the Environmental Protection Agency's Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, for providing the basic methodology used in this manual.

ORIGINAL (Red)

CONVERSION TABLE

The sections and methods of the first edition of this manual are given on the lefthand side of the page, and the location of their replacements is given on the righthand side.

First Edition		Current (Second) Edition
1.0	Evaluation Plan Design	Section 1.0
2.0	Chain of Custody Procedures	Section 1.3
3.0	Sampling Methodology	Section 1.4
3.1	Sampling Plan Design	Section 1.1
3.2	Sampling Equipment	Section 1.2.1
3.3	Sample Containers	Section 1.4.1
3.4	Sampling Handling & Preservation	Section 1.3; also see individual method
4.0	Ignitability	Section 2.1.1
5.0	Corrosivity	Section 2.1.2
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6.0	Reactivity	Section 2.1.3
7.0	Extraction Procedure Toxicity (EP Tox)	Section 2.1.4
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	Gas Chromatographic Methods	8000, 8100 series of methods
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8.02	Volatile aromatics, selected ketones and ethers	Method 8090
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8.04	Phenols	Method 8040
8.06	Semi-volatile organics	Method 8060
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8.12	Semi-volatile chlorinated hydrocarbons	Method 8120
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8.24	Volatile organics	Method 8240
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8.49	General Requirements	
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First Edition		Current (Second) Edition
9.0	Interference Removal Procedures	See individual method
	9.01 Liquid-Liquid Extraction	Method 3520
10.0	Quality Control/Quality Assurance	Section 10
11.0	Suppliers	See individual method

SECTION ONE

SAMPLING OF SOLID WASTES

The initial and perhaps most critical element in a program designed to evaluate the physical and chemical properties of a solid waste is the plan for sampling the waste. It is understandable that analytical studies, with their sophisticated instrumentation and high cost, are often perceived as the dominant element in a waste characterization program. Yet, despite that sophistication and high cost, analytical data generated by a scientifically defective sampling plan have limited utility, particularly in the case of regulatory proceedings.

This section of the manual addresses the development and implementation of a scientifically credible sampling plan for a solid waste and the documentation of the chain of custody for such a plan. The information presented in this section is relevant to the sampling of any solid waste, which has been defined by the EPA in its regulations for the identification and listing of hazardous wastes to include solid, semisolid, liquid, and contained gaseous materials. However, the physical and chemical diversity of those materials, as well as the dissimilar storage facilities (lagoons, open piles, tanks, drums, etc.) and sampling equipment associated with them, preclude a detailed consideration of any specific sampling plan. Consequently, since the burden of responsibility for developing a technically sound sampling plan rests with the waste producer, it is advisable that he seek competent advice before designing a plan. This is particularly true in the early developmental stages of a sampling plan, which require at least a basic understanding of applied statistics. Applied statistics is the science of employing techniques that allow the uncertainty of inductive inferences (general conclusions based on partial knowledge) to be evaluated.

1.1 Development of Appropriate Sampling Plans

An appropriate sampling plan for a solid waste must be responsive to both regulatory and scientific objectives. Once those objectives have been clearly identified, a suitable sampling strategy, predicated upon fundamental statistical concepts, can be developed. The statistical terminology associated with those concepts is reviewed in Table 1.

1.1.1 Regulatory and Scientific Objectives

The EPA, in its hazardous waste management system, has required that certain solid wastes be analyzed for physical and chemical properties. It is mostly chemical properties that are of concern, and, in the case of a number of chemical contaminants, the EPA has promulgated levels (regulatory thresholds) that cannot be equaled or exceeded. The regulations pertaining to the

TABLE 1.--BASIC STATISTICAL TERMINOLOGY APPLICABLE TO SAMPLING PLANS FOR SOLID WASTES

Terminology	Symbol	Mathematical equation	(Equation)
• Variable (e.g., barium or endrin)	X	---	
• Individual measurement of variable	X_i	---	
• Mean of all possible measurements of variable (population mean)	μ	$\mu = \frac{\sum_{i=1}^{N} X_i}{N}$, with N = number of possible measurements	(1)
• Mean of measurements generated by sample (sample mean)	$\bar{x}$	Simple random sampling and systematic random sampling $\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n}$, with n = number of sample measurements	(2a)
		Stratified random sampling $\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k$, with $\bar{x}_k$ = stratum mean and W_k = fraction of population represented by Stratum k (number of strata [k] ranges from 1 to r)	(2b)
• Variance of sample	s^2	Simple random sampling and systematic random sampling $s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n-1}$	(3a)
		Stratified random sampling $s^2 = \sum_{k=1}^{r} W_k s_k^2$, with s_k^2 = stratum variance and W_k = fraction of population represented by Stratum k (number of strata [k] ranges from 1 to r)	(3b)
• Standard deviation of sample	s	$s = \sqrt{s^2}$	(4)
• Standard error (also standard error of mean and standard deviation of mean) of sample	$s_{\bar{x}}$	$s_{\bar{x}} = \frac{s}{\sqrt{n}}$	(5)
• Confidence interval for μ[a]	CI	$CI = \bar{x} \pm t_{.20}\, s_{\bar{x}}$, with $t_{.20}$ obtained from Table 2 in this section for appropriate degrees of freedom	(6)
• Regulatory threshold[a]	RT	Defined by EPA (e.g., 100 ppm for barium in elutriate of EP toxicity test)	(7)
• Appropriate number of samples to collect from a solid waste (financial [...]	n	$n = \frac{t_{.20}^2 s^2}{\Delta^2}$, with $\Delta = RT - \bar{x}$	(8)

TABLE 1 (Continued)

Terminology	Symbol	Mathematical equation	(Equation)
• Degrees of freedom	df	$df = n - 1$	(9)
• Square root transformation	---	$\sqrt{X_i + 1/2}$	(10)
• Arcsin transformation	---	$\text{Arcsin}\sqrt{p}$; if necessary, refer to any text on basic statistics; measurements must be converted to percentages (p)	(11)

[a]The upper limit of the CI for μ is compared to the applicable regulatory threshold (RT) to determine if a solid waste contains the variable (chemical contaminant) of concern at a hazardous level. The contaminant of concern is not considered to be present in the waste at a hazardous level if the upper limit of the CI is less than the applicable RT. Otherwise, the opposite conclusion is reached.

TABLE 2. TABULATED VALUES OF STUDENT'S "t" FOR EVALUATING SOLID WASTES

Degrees of freedom (n-1)[a]	Tabulated "t" value[b]
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
30	1.310
40	1.303
60	1.296
120	1.289
∞	1.282

[a]Degrees of freedom (df) are equal to the number of samples (n) collected from a solid waste less one.

[b]Tabulated "t" values are for a two-tailed confidence interval and a probability of 0.20 (the same values are applicable to a one-tailed confidence interval and a probability of 0.10).

management of hazardous wastes contain three references regarding the sampling of solid wastes for analytical properties. The first reference, which occurs throughout the regulations, requires that representative samples of waste be collected and defines representative samples as exhibiting average properties of the whole waste. The second reference, which pertains just to petitions to exclude wastes from being listed as hazardous wastes, specifies that enough samples (but in no case less than four samples) be collected over a period of time sufficient to represent the variability of the wastes. The third reference, which applies only to groundwater monitoring systems, mandates that four replicates (subsamples) be taken from each groundwater sample intended for chemical analysis and that the mean concentration and variance for each chemical constituent be calculated from those four subsamples and compared to background levels for groundwater. Even the statistical test to be employed in that comparison is specified (Student's t-test).

The first of the above-described references addresses the issue of sampling accuracy, while the second and third references focus on sampling variability or, conversely, sampling precision (actually the third reference relates to analytical variability, which, in many statistical tests, cannot be distinguished from true sampling variability). Sampling accuracy (the closeness of a sample value to its true value) and sampling precision (the closeness of repeated sample values) are also the issues of overriding importance in any scientific assessment of sampling practices. Thus, from both regulatory and scientific perspectives, the primary objectives of a sampling plan for a solid waste are twofold - namely, to collect samples that will allow sufficiently accurate and precise measurements of the chemical properties of the waste. If the chemical measurements are sufficiently accurate and precise, they will be considered reliable estimates of the chemical properties of the waste.

It is now apparent that a judgment must be made as to the degree of sampling accuracy and precision that is required to reliably estimate the chemical characteristics of a solid waste for the purpose of comparing those characteristics to applicable regulatory thresholds. Generally, high accuracy and high precision are required if one or more chemical contaminants of a solid waste is present at a concentration that is close to the applicable regulatory threshold. Alternatively, relatively low accuracy and low precision can be tolerated if the contaminants of concern occur at levels far below or far above their applicable thresholds. However, a word of caution is in order. Low sampling precision is often associated with considerable savings in analytical, as well as sampling, costs and is clearly recognizable even in the simplest of statistical tests. On the other hand, low sampling accuracy may not entail cost savings and is always obscured (cannot be evaluated) in statistical tests. Therefore, while it is desirable to design sampling plans for solid wastes to achieve only the minimally required precision (at least two samples of a material are required for any estimate of precision), it is prudent to design the plans to attain the greatest possible accuracy.

The roles that inaccurate and imprecise sampling can play in causing a solid waste to be inappropriately judged hazardous are illustrated in Figure 1. When evaluating Figure 1, several points are worthy of consideration. Although a sampling plan for a solid waste generates a mean concentration ($\bar{x}$) and standard deviation (s, a measure of the extent to which individual sample concentrations are dispersed around $\bar{x}$) for each chemical contaminant of concern, it is not the variation of individual sample concentrations that is of ultimate concern, but rather, the variation that characterizes $\bar{x}$ itself. That measure of dispersion is termed the standard deviation of the mean (also, the standard error of the mean or standard error) and is designated as $s_{\bar{x}}$. Those two samples values, $\bar{x}$ and $s_{\bar{x}}$, are used to estimate the interval (range) within which the true mean (μ) of the chemical concentration probably occurs, assuming that the individual concentrations exhibit a normal (bell-shaped) distribution. For the purposes of evaluating solid wastes, the probability level (confidence interval) of 80% has been selected. That is, for each chemical contaminant of concern, a confidence interval (CI) is described within which μ occurs if the sample is representative, which is expected of about 80 out of 100 samples. The upper limit of the 80% CI is then compared to the appropriate regulatory threshold. If the upper limit is less than the threshold, the chemical contaminant is not considered to be present in the waste at a hazardous level; otherwise, the opposite conclusion is drawn. One last point merits explanation. Even if the upper limit of an estimated 80% CI is only slightly less than the regulatory threshold (the worst case of chemical contamination that would be judged acceptable), there is only a 10% (not 20%) chance that the threshold is equaled or exceeded. That is because values of a normally distributed contaminant that are outside the limits of an 80% CI are equally distributed between the left (lower) and right (upper) tails of the normal curve. Consequently, the CI employed to evaluate solid wastes is, for all practical purposes, a 90% interval.

1.1.2 Fundamental Statistical Concepts

The concepts of sampling accuracy and precision have already been introduced along with some measurements of central tendency ($\bar{x}$) and dispersion (standard deviation [s] and $s_{\bar{x}}$) for concentrations of a chemical contaminant of a solid waste. The utility of $\bar{x}$ and $s_{\bar{x}}$ in estimating a confidence interval that probably contains the true mean (μ) concentration of a contaminant has also been described. However, it was noted that the validity of that estimate is predicated upon the assumption that individual concentrations of the contaminant exhibit a normal distribution.

Statistical techniques for obtaining accurate and precise samples are relatively simple and easy to implement. Sampling accuracy is usually achieved by some form of random sampling. In random sampling, every unit in the population (e.g., every location in a lagoon used to store a solid waste) has a theoretically equal chance of being sampled and measured. Consequently,

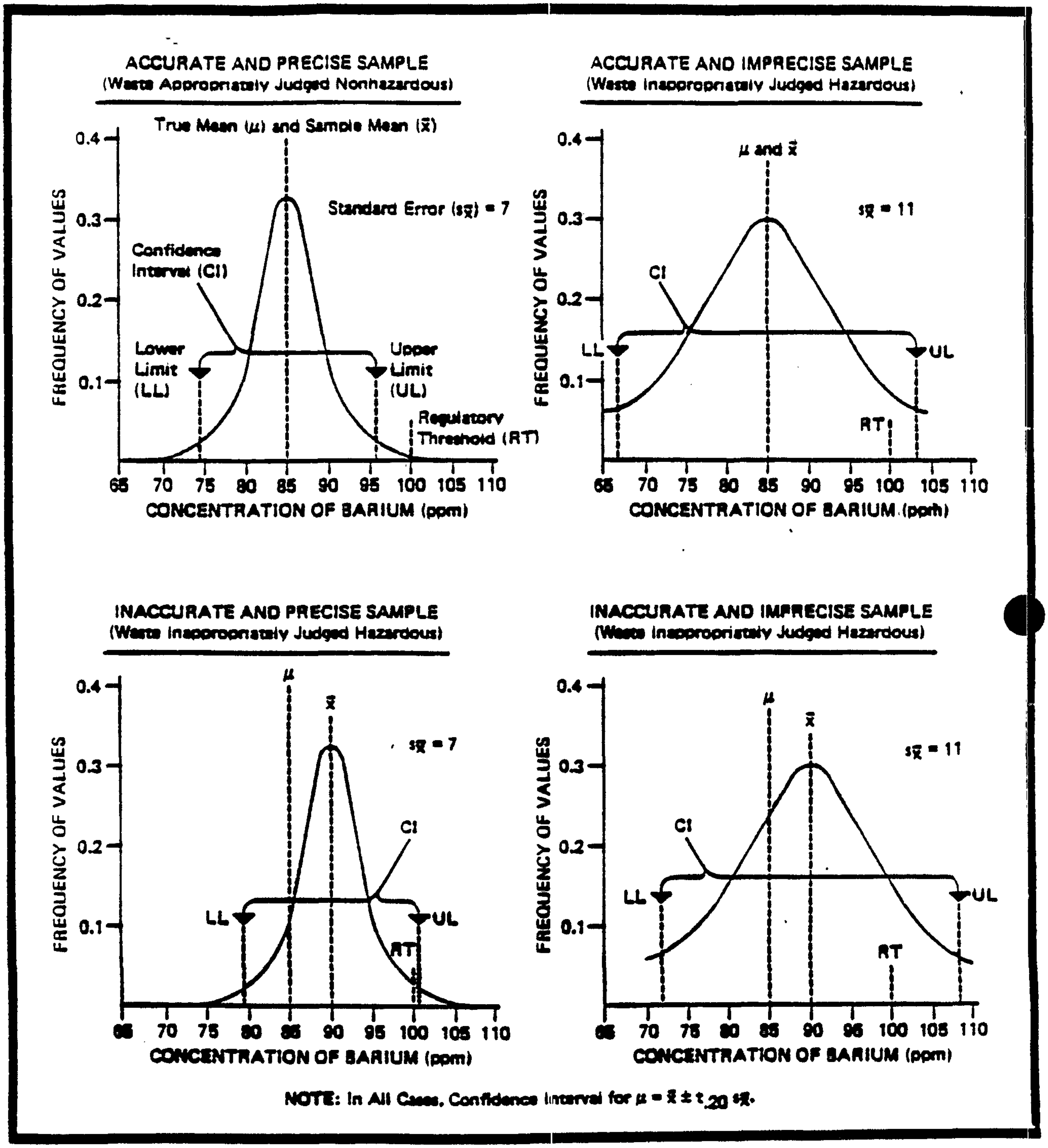

Figure 1.—Important theoretical relationships between sampling accuracy and precision and regulatory objectives for a chemical contaminant of a solid waste that occurs at a concentration marginally less than its regulatory threshold. In this example, barium is the chemical contaminant. The true mean concentration of barium in the elutriate of the EP toxicity test is 85 ppm, as compared to a regulatory threshold of 100 ppm. The upper limit of the confidence interval for the true mean concentration, which is estimated from the sample mean and standard error, must be less than the regulatory threshold if barium is judged to be present in the waste at a nonhazardous level.

statistics generated by the sample (e.g., $\bar{x}$, and, to a lesser degree, $s_{\bar{x}}$) are unbiased (accurate) estimators of true population parameters (e.g., the CI for μ). In other words, the sample is representative of the population. One of the commonest methods of selecting a random sample is to divide the population by an imaginary grid, assign a series of consecutive numbers to the units of the grid, and select the numbers (units) to be sampled through the use of a random numbers table (such a table can be found in any text on basic statistics). It is important to emphasize that a haphazardly selected sample is not a suitable substitute for a randomly selected sample. That is because there is no assurance that a person performing undisciplined sampling will not consciously or subconsciously favor the selection of certain units of the population, thus causing the sample to be unrepresentative of the population.

Sampling precision is most commonly achieved by taking an appropriate number of samples from the population. As can be observed from the equation for calculating $s_{\bar{x}}$, precision increases ($s_{\bar{x}}$ and the CI for μ decrease) as the number of samples (n) increases, although not in a 1:1 ratio. For example, a 100% increase in the number of samples from two to four causes the CI to decrease by approximately 62% (about 31% of that decrease is associated with the critical upper tail of the normal curve). However, another 100% increase in sampling effort from four to eight samples results in only an additional 39% decrease in the CI. Another technique for increasing sampling precision is to maximize the physical size (weight or volume) of the samples that are collected. That has the effect of minimizing between-sample variation and, consequently, decreasing $s_{\bar{x}}$. Increasing the number or size of samples taken from a population, in addition to increasing sampling precision, has the secondary effect of increasing sampling accuracy.

In summary, reliable information concerning the chemical properties of a solid waste is needed for the purpose of comparing those properties to applicable regulatory thresholds. If chemical information is to be considered reliable, it must be accurate and sufficiently precise. Accuracy is usually achieved by incorporating some form of randomness into the selection process for the samples that generate the chemical information. Sufficient precision is most often obtained by selecting an appropriate number of samples.

There are a few ramifications of the above-described concepts that merit elaboration. If, for example, as in the case of semiconductor etching solutions, each batch of a waste is completely homogeneous with regard to the chemical properties of concern and that chemical homogeneity is constant (uniform) over time (from batch to batch), a single sample collected from the waste at an arbitrary location and time would theoretically generate an accurate and precise estimate of the chemical properties. However, most wastes are heterogeneous in terms of their chemical properties. If a batch of waste is randomly heterogeneous with regard to its chemical characteristics and that random chemical heterogeneity remains constant from batch to batch, accuracy and appropriate precision can usually be achieved by simple random sampling. In that type of sampling, all units in the population (essentially all locations or points in all batches of waste from which a sample could be collected) are identified, and a suitable number of samples is randomly selected from the population. More complex stratified random sampling is appropriate if a batch of waste is known to be nonrandomly heterogeneous in terms of its chemical properties and/or nonrandom chemical heterogeneity is known to exist from batch to batch. In such cases, the population is stratified to isolate the known sources of nonrandom chemical heterogeneity. After stratification, which may occur over space (locations or points in a batch of waste) and/or time (each batch of waste), the units in each stratum are numerically identified, and a simple random sample is taken from each stratum. As previously intimated, both simple and stratified random sampling generate accurate estimates of the chemical properties of a solid waste. The advantage of stratified random sampling over simple random sampling is that, for a given number of samples and a given sample size, the former technique often results in a more precise estimate of chemical properties of a waste (a lower value of $s_{\bar{x}}$) than the latter technique. However, greater precision is likely to be realized only if a waste exhibits substantial nonrandom chemical heterogeneity and stratification efficiently "divides" the waste into strata that exhibit maximum between-strata variability and minimum within-strata variability. If that does not occur, stratified random sampling can produce results that are less precise than in the case of simple random sampling. Therefore, it is reasonable to select stratified random sampling over simple random sampling only if the distribution of chemical contaminants in a waste is sufficiently known to allow an intelligent identification of strata and at least two or three samples can be collected in each stratum. If a strategy employing stratified random sampling is selected, a decision must be made regarding the allocation of sampling effort among strata. When chemical variation within each stratum can be estimated with a great degree of detail, samples should be optimally allocated among strata, i.e., the number of samples collected from each stratum should be directly proportional to the chemical variation encountered in the stratum. When detailed information concerning chemical variability within strata is not available, samples should be proportionally allocated among strata, i.e., sampling effort in each stratum should be directly proportional to the size of the stratum.

Simple random sampling and stratified random sampling are types of probability sampling, which, because of a reliance upon mathematical and statistical theories, allows an evaluation of the effectiveness of sampling procedures. Another type of probability sampling is systematic random sampling, in which the first unit to be collected from a population is randomly selected, but all subsequent units are taken at fixed space or time intervals. An example of systematic random sampling is the sampling of a waste lagoon along a transect in which the first sampling point on the transect is 1 m from a randomly selected location on the shore and subsequent sampling points are located at 2-m intervals along the transect. The advantages of systematic random sampling over simple random sampling and stratified random sampling are the ease in which samples are identified and collected (the selection of the first sampling unit determines the remainder of the units) and, sometimes, an increase in precision. In certain cases, for example, systematic random sampling might be expected to be a little more precise than stratified random sampling with one unit per stratum because samples are distributed more evenly over the population. As will be demonstrated shortly, disadvantages of systematic random sampling are the poor accuracy and precision that can occur when unrecognized trends or cycles occur in the population. For those reasons, systematic random sampling is recommended only when a population is essentially random or contains at most a modest stratification. In such cases, systematic random sampling would be employed for the sake of convenience, with little expectation of an increase in precision over other random sampling techniques.

Probability sampling is contrasted with authoritative sampling, in which an individual who is well acquainted with the solid waste to be sampled selects a sample without regard to randomization. The validity of data gathered in that manner is totally dependent on the knowledge of the sampler and, although valid data can sometimes be obtained, authoritative sampling is not recommended for the chemical characterization of most wastes.

It may now be useful to offer a generalization regarding the four sampling strategies that have been identified for solid wastes. If little or no information is available concerning the distribution of chemical contaminants of a waste, simple random sampling is the most appropriate sampling strategy. As more information is accumulated for the contaminants of concern, greater consideration can be given (in order of the additional information required) to stratified random sampling, systematic random sampling, and, perhaps, authoritative sampling.

The validity of a CI for the true mean (μ) concentration of a chemical contaminant of a solid waste is, as previously noted, based on the assumption that individual concentrations of the contaminant exhibit a normal distribution. This is true regardless of the strategy that is employed to sample the waste. Although there are computational procedures for evaluating the correctness of the assumption of normality, those procedures are meaningful only if a large number of samples are collected from a waste. Since sampling plans for most solid wastes entail just a few samples, one can do little more than superficially examine resulting data for obvious departures from normality (this can be done by simple graphical methods), keeping in mind that even if individual measurements of a chemical contaminant of a waste exhibit a considerably abnormal distribution, such abnormality is not likely to be the case for sample means, which are our primary concern. One can also compare the mean of the sample ($\bar{x}$) to the variance of the sample (s^2). In a normally distributed population, $\bar{x}$ would be expected to be greater than s^2 (assuming that the number of samples [n] is reasonably large). If that is not the case, the chemical contaminant of concern may be characterized by a Poisson distribution ($\bar{x}$ is approximately equal to s^2) or a negative binomial distribution ($\bar{x}$ is less than s^2). In the former circumstance, normality can often be achieved by transforming data according to the square root transformation. In the latter circumstance, normality may be realized through use of the arcsine transformation.

If either transformation is required, all subsequent statistical evaluations must be performed on the transformed scale.

Finally, it is necessary to address the appropriate number of samples to be employed in the chemical characterization of a solid waste. As has already been emphasized, the appropriate number of samples is the least number of samples required to generate a sufficiently precise estimate of the true mean (μ) concentration of a chemical contaminant of a waste. From the perspective of most waste producers, that means the minimal number of samples needed to demonstrate that the upper limit of the CI for μ is less than the applicable regulatory threshold (RT). The formula for estimating appropriate sampling effort (Table 1, Equation 8) indicates that increased sampling effort is generally justified as s^2 or the "$t_{.20}$" value (probable error rate) increases and as Δ (RT - $\bar{x}$) decreases. In a well-designed sampling plan for a solid waste, an effort is made to estimate the values of $\bar{x}$ and s^2 before sampling is initiated. Such preliminary estimates, which may be derived from information pertaining to similar wastes, process engineering data, or limited analytical studies, are used to identify the approximate number of samples that must be collected from the waste. It is always prudent to collect a somewhat greater number of samples than indicated by preliminary estimates of $\bar{x}$ and s^2 since poor preliminary estimates of those statistics can result in an underestimate of the appropriate number of samples to collect. It is usually possible to appropriately process and store the extra samples until analysis of the initially identified samples is completed and it can be determined if analysis of the additional samples is warranted.

1.1.3 Basic Sampling Strategies

It is now appropriate to present general procedures for implementing the three previously introduced sampling strategies (simple random sampling, stratified random sampling, and systematic random sampling) and a hypothetical example of each sampling strategy. The hypothetical examples illustrate the statistical calculations that must be performed in most situations likely to be encountered by a waste producer and, also, provide some insight into the efficiency of the three sampling strategies in meeting regulatory objectives.

The following hypothetical conditions are assumed to exist for all three sampling strategies. First, barium, which has a RT of 100 ppm as measured in the EP elutriate test, is the only chemical contaminant of concern. Second, barium is discharged in particulate form to a waste lagoon and accumulates in the lagoon in the form of a sludge, which has built up to approximately the same thickness throughout the lagoon. Third, concentrations of barium are relatively homogeneous along the vertical gradient (from the water-sludge interface to the sludge-lagoon interface), suggesting a highly controlled manufacturing process (little between-batch variation in barium concentrations).

Fourth, the physical size of sludge samples collected from the lagoon is as large as practical, and barium concentrations derived from those samples are normally distributed (note that we do not refer to barium levels in the samples of sludge since barium measurements are actually made on the elutriate from EP toxicity tests performed with the samples). Last, a preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago identified values of 86 and 90 ppm for material collected near the outfall (in the upper third) of the lagoon and values of 98 and 104 ppm for material obtained from the far end (the lower two-thirds) of the lagoon.

For all sampling strategies, it is important to remember that barium will be determined to be present in the sludge at a hazardous level if the upper limit of the CI for μ is equal to or greater than the RT of 100 ppm (Table 1, Equations 6 and 7).

1.1.3.1 Simple Random Sampling

Simple random sampling (Box 1) is performed by general procedures in which preliminary estimates of $\bar{x}$ and s^2, as well as a knowledge of the RT, for each chemical contaminant of a solid waste that is of concern are employed to estimate the appropriate number of samples (n) to be collected from the waste. That number of samples is subsequently analyzed for each chemical contaminant of concern. The resulting analytical data are then used to definitively conclude that each contaminant is or is not present in the waste at a hazardous concentration or, alternatively, to suggest a reiterative process, involving increased sampling effort, through which the presence or absence of hazard can be definitively determined.

In the hypothetical example for simple random sampling (Box 1), preliminary estimates of $\bar{x}$ and s^2 indicated a sampling effort consisting of six samples. That number of samples was collected and initially analyzed, generating analytical data somewhat different from the preliminary data (s^2 was substantially greater than was preliminarily estimated). Consequently, the upper limit of the CI was unexpectedly greater than the applicable RT, resulting in a tentative conclusion of hazard. However, a reestimation of appropriate sampling effort, based on statistics derived from the six samples, suggested that such a conclusion might be reversed through the collection and analysis of just one more sample. Fortunately, a resampling effort was not required because of the foresight of the waste producer in obtaining three extra samples during the initial sampling effort, which, because of their influence in decreasing the final values of $\bar{x}$, $s_{\bar{x}}$, $t_{.20}$, and, consequently, the upper limit of the CI - values obtained from all nine samples - resulted in a definitive conclusion of nonhazard.

BOX 1. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - SIMPLE RANDOM SAMPLING OF WASTES

Step	General Procedures
1.	Obtain preliminary estimates of $\bar{x}$ and s^2 for each chemical contaminant of a solid waste that is of concern. The two above-identified statistics are calculated by, respectively, Equations 2a and 3a (Table 1).
2.	Estimate the appropriate number of samples (n_1) to be collected from the waste through use of Equation 8 (Table 1) and Table 2. Derive individual values of n_1 for each chemical contaminant of concern. The appropriate number of samples to be taken from the waste is the greatest of the individual n_1 values.
3.	Randomly collect at least n_1 samples (or $n_2 - n_1$, $n_3 - n_2$, etc. samples, as will be indicated later in this box) from the waste (collection of a few extra samples will provide protection against poor preliminary estimates of $\bar{x}$ and s^2). Maximize the physical size (weight or volume) of all samples that are collected.
4.	Analyze the n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc.) samples for each chemical contaminant of concern. Superficially (graphically) examine each set of analytical data for obvious departures from normality.
5.	Calculate $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ for each set of analytical data by, respectively, Equations 2a, 3a, 4, and 5 (Table 1).
6.	If $\bar{x}$ for a chemical contaminant is equal to or greater than the applicable RT (Equation 7; Table 1)) and is believed to be an accurate estimator of μ, the contaminant is considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with nontransformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data. Square root and arcsine transformations are defined by, respectively, Equations 10 and 11 (Table 1).
7.	Determine the CI for each chemical contaminant of concern by Equation 6 (Table 1) and Table 2. If the upper limit of the CI is less than the applicable RT (Equations 6 and 7; Table 1), the chemical contaminant is not considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

8. If a tentative conclusion of hazard is reached, reestimate the total number of samples (n_2) to be collected from the waste by use of Equation 8 (Table 1) and Table 2. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If an additional $n_2 - n_1$ samples of waste cannot reasonably be collected, the study is completed and a definitive conclusion of hazard is reached. Otherwise, collect an extra $n_2 - n_1$ samples of waste.

9. Repeat the basic operations described in Steps 3-8 until the waste is judged to be nonhazardous or, if the opposite conclusion continues to be reached, increased sampling effort is impractical.

Hypothetical Example

Step

1. The preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago generated values of 86 and 90 ppm for sludge obtained from the upper third of the lagoon and values of 98 and 104 ppm for sludge from the lower two-thirds of the lagoon. Those two sets of values are not judged to be indicative of nonrandom chemical heterogeneity (stratification) within the lagoon. Therefore, preliminary estimates of $\bar{x}$ and s^2 are calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{86 + 90 + 98 + 104}{4} = 94.50, \text{ and} \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{35,916.00 - 35,721.00}{3} = 65.00.$$

2. Based on the preliminary estimates of $\bar{x}$ and s^2, as well as the knowledge that the RT for barium is 100 ppm,

$$n_1 = \frac{t_{.20}^2 s^2}{\Delta^2} = \frac{(1.638^2)(65.00)}{5.50^2} = 5.77. \qquad \text{(Equation 8)}$$

3. As indicated above, the appropriate number of sludge samples (n_1) to be collected from the lagoon is six. That number of samples (plus three extra samples for protection against poor preliminary estimates of $\bar{x}$ and s^2) is collected from the lagoon by a single randomization process (Figure 2). All samples consist of the greatest volume of sludge that can be practically collected. The three extra samples are suitably processed and stored for possible later analysis.

4. The six samples of sludge (n_1) designated for immediate analysis generate the following concentrations of barium in the EP toxicity test: 89, 90, 87, 96, 93, and 113 ppm. Although the value of 113 ppm appears unusual as compared to the other data, there is no obvious indication that the data are not normally distributed.

5. New values for $\bar{x}$ and s^2 and associated values for the standard deviation (s) and $s_{\bar{x}}$ are calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{89 + 90 + 87 + 96 + 93 + 113}{6} = 94.67, \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{54,224.00 - 53,770.67}{5} = 90.67,$$

$$s = \sqrt{s^2} = 9.52, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 9.52/\sqrt{6} = 3.89. \qquad \text{(Equation 5)}$$

6. The new value for $\bar{x}$ (94.67) is less than the RT (100). In addition, $\bar{x}$ is greater (only slightly) than s^2 (90.67) and, as previously indicated, the raw data are not characterized by obvious abnormality. Consequently, the study is continued, with the following calculations performed with nontransformed data.

7. $$\text{CI} = \bar{x} \pm t_{.20}\, s_{\bar{x}} = 94.67 \pm (1.476)(3.89) \qquad \text{(Equation 6)}$$

$$= 94.67 \pm 5.74.$$

Since the upper limit of the CI (100.41) is greater than the applicable RT (100), it is tentatively concluded that barium is present in the sludge at a hazardous concentration.

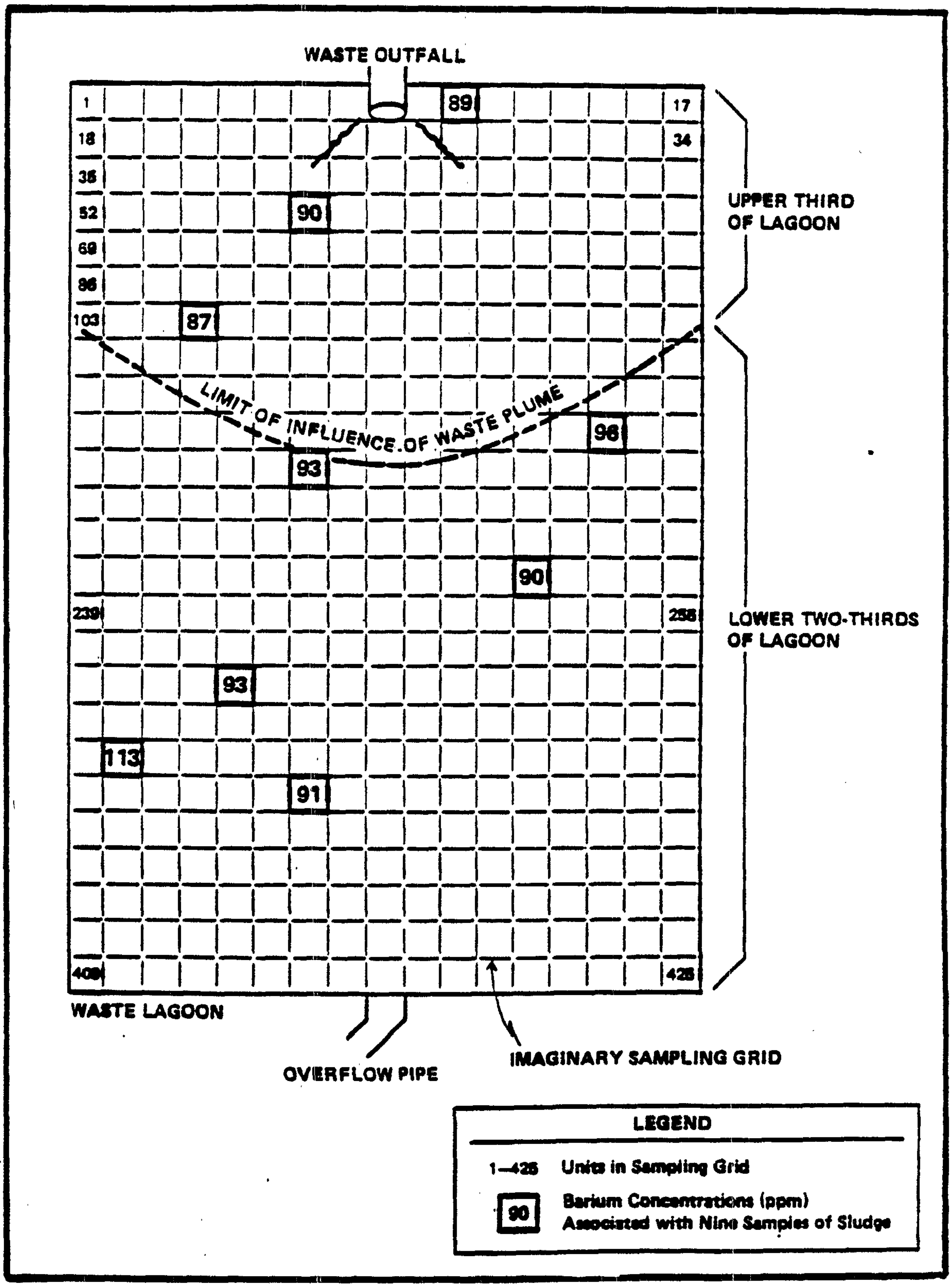

Figure 2.—Hypothetical sampling conditions in waste lagoon containing sludge contaminated with barium. Barium concentrations associated with samples of sludge refer to levels measured in the elutriate of EP toxicity tests conducted with the samples.

8. n is now reestimated as:

$$n_2 = \frac{t^2_{.20}s^2}{\Delta^2} \quad \frac{(1.476^2)(90.67)}{5.33^2} = 6.95. \qquad \text{(Equation 8)}$$

The value for n_2 ($\sim$7) indicates that an additional ($n_2 - n_1 = 1$) sludge sample should be collected from the lagoon.

9. The additional sampling effort is not necessary because of the three extra samples that were initially collected from the lagoon. All extra samples are analyzed, generating the following levels of barium for the EP toxicity test: 93, 90, and 91 ppm. Consequently, $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ are recalculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{89 + 90 + \ldots + 91}{9} = 93.56, \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{79{,}254.00 - 78{,}773.78}{8} = 60.03,$$

$$s = \sqrt{s^2} = 7.75, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 7.75/\sqrt{9} = 2.58. \qquad \text{(Equation 5)}$$

The value for $\bar{x}$ (93.56) is again less than the RT (100), and there is no indication that the nine data points, considered collectively, are abnormally distributed (in particular, $\bar{x}$ is now substantially greater than s^2). Consequently, CI, calculated with nontransformed data, is determined to be:

$$CI = \bar{x} \pm t_{.20}s_{\bar{x}} = 93.56 \pm (1.397)(2.58) \qquad \text{(Equation 6)}$$

$$= 93.56 \pm 3.60.$$

The upper limit of the CI (97.16) is now less than the RT of 100. Consequently, it is definitively concluded that barium is not present in the sludge at a hazardous level.

1.1.3.2 Stratified Random Sampling

Stratified random sampling (Box 2) is conducted by general procedures that are similar to the procedures described for simple random sampling. The only difference is that, in stratified random sampling, values of $\bar{x}$ and s^2 are calculated for each stratum in the population and then integrated into overall estimates of those statistics, the standard deviation (s), $s_{\bar{x}}$, and the appropriate number of samples (n) for all strata.

The hypothetical example for stratified random sampling (Box 2) is based on the same nine sludge samples previously identified in the example of simple random sampling (Box 1) so that the relative efficiencies of the two sampling strategies can be fully compared. The efficiency generated through the process of stratification is first evident in the preliminary estimate of n (Step 2 in Boxes 1 and 2), which is six for simple random sampling and four for stratified random sampling. (The lesser value for stratified sampling is the consequence of a dramatic decrease in s^2, which more than compensated for a modest increase in Δ.) The most relevant indication of sampling efficiency is the value of $s_{\bar{x}}$, which is directly employed to calculate the CI. In the case of simple random sampling, $s_{\bar{x}}$ is calculated as 2.58 (Step 9 in Box 1), while, for stratified random sampling, $s_{\bar{x}}$ is determined to be 2.35 (Steps and 5 and 7 in Box 2). Consequently, the gain in efficiency attributable to stratification is approximately 9% (0.23/2.58).

1.1.3.3 Systematic Random Sampling

Systematic random sampling (Box 3) is implemented by general procedures that are identical to the procedures identified for simple random sampling. The hypothetical example for systematic random sampling (Box 3) demonstrates the bias and imprecision that are associated with that type of sampling when unrecognized trends or cycles exist in the population.

1.1.4 Special Considerations

The preceding discussion has addressed the major issues that are critical to the development of a reliable sampling strategy for a solid waste. The remaining discussion focuses on several "secondary" issues that should be considered when designing an appropriate sampling strategy. These secondary issues are applicable to all three of the basic sampling strategies that have been identified.

BOX 2. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - STRATIFIED RANDOM SAMPLING OF WASTES

Step	General Procedures
1.	Obtain preliminary estimates of $\bar{x}$ and s^2 for each chemical contaminant of a solid waste that is of concern. The two above-identified statistics are calculated by, respectively, Equations 2b and 3b (Table 1).
2.	Estimate the appropriate number of samples (n_1) to be collected from the waste through use of Equation 8 (Table 1) and Table 2. Derive individual values of n_1 for each chemical contaminant of concern. The appropriate number of samples to be taken from the waste is the greatest of the individual n_1 values.
3.	Randomly collect at least n_1 samples (or $n_2 - n_1$, $n_3 - n_2$, etc. samples, as will be indicated later in this box) from the waste (collection of a few extra samples will provide protection against poor preliminary estimates of $\bar{x}$ and s^2). If s_k for each stratum (see Equation 3b) is believed to be an accurate estimate, optimally allocate samples among strata (i.e., allocate samples among strata so that the number of samples collected from each stratum is directly proportional to s_k for that stratum). Otherwise, proportionally allocate samples among strata according to size of the strata. Maximize the physical size (weight or volume) of all samples that are collected from the strata.
4.	Analyze the n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc.) samples for each chemical contaminant of concern. Superficially (graphically) examine each set of analytical data from each stratum for obvious departures from normality.
5.	Calculate $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ for each set of analytical data by, respectively, Equations 2b, 3b, 4, and 5 (Table 1).
6.	If $\bar{x}$ for a chemical contaminant is equal to or greater than the applicable RT (Equation 7; Table 1) and is believed to be an accurate estimator of μ, the contaminant is considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with nontransformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data. Square root and arcsine transformations are defined by, respectively, Equations 10 and 11 (Table 1).

7. Determine the CI for each chemical contaminant of concern by Equation 6 (Table 1) and Table 2. If the upper limit of the CI is less than the applicable RT (Equations 6 and 7; Table 1), the chemical contaminant is not considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

8. If a tentative conclusion of hazard is reached, reestimate the total number of samples (n_2) to be collected from the waste by use of Equation 8 (Table 1) and Table 2. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If an additional $n_2 - n_1$ samples of waste cannot reasonably be collected, the study is completed and a definitive conclusion of hazard is reached. Otherwise, collect an extra $n_2 - n_1$ samples of waste.

9. Repeat the basic operations described in Steps 3-8 until the waste is judged to be nonhazardous or, if the opposite conclusion continues to be reached, increased sampling effort is impractical.

Hypothetical Example

Step

1. The preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago generated values of 86 and 90 ppm for sludge obtained from the upper third of the lagoon and values of 98 and 104 ppm for sludge from the lower two-thirds of the lagoon. Those two sets of values are judged to be indicative of nonrandom chemical heterogeneity (two strata) within the lagoon. Therefore, preliminary estimates of $\bar{x}$ and s^2 are calculated as:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k = \frac{(1)(88.00)}{3} + \frac{(2)(101.00)}{3} = 96.67, \text{ and} \qquad \text{(Equation 2b)}$$

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 = \frac{(1)(8.00)}{3} + \frac{(2)(18.00)}{3} = 14.67. \qquad \text{(Equation 3b)}$$

2. Based on the preliminary estimates of $\bar{x}$ and s^2, as well as the knowledge that the RT for barium is 100 ppm,

$$n_1 = \frac{t_{.20}^2 s^2}{\Delta^2} = \frac{(1.368^2)(14.67)}{3.33^2} = 3.55. \qquad \text{(Equation 8)}$$

3. As indicated above, the appropriate number of sludge samples (n_1) to be collected from the lagoon is four. However, for purposes of comparison to simple random sampling (Box 1), six samples (plus three extra samples for protection against poor preliminary estimates of $\bar{x}$ and s^2) are collected from the lagoon by a two-stage randomization process (Figure 2). Because s_k for the upper (2.12 ppm) and lower (5.66 ppm) strata are not believed to be very accurate estimates, the nine samples to be collected from the lagoon are not optimally allocated between the two strata (optimum allocation would require two and seven samples to be collected from the upper and lower strata, respectively). Alternatively, proportional allocation is employed - three samples are collected from the upper stratum (which represents one-third of the lagoon), and six samples are taken from the lower stratum (two-thirds of the lagoon). All samples consist of the greatest volume of sludge that can be practically collected.

4. The nine samples of sludge generate the following concentrations of barium in the EP toxicity test: upper stratum - 89, 90, and 87 ppm; lower stratum - 96, 93, 113, 93, 90, and 91 ppm. Although the value of 113 ppm appears unusual as compared to other data for the lower stratum, there is no obvious indication that the data are not normally distributed.

5. New values for $\bar{x}$ and s^2 and associated values for the standard deviation (s) and $s_{\bar{x}}$ are calculated as:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k = \frac{(1)(88.67)}{3} + \frac{(2)(96.00)}{3} = 93.56, \qquad \text{(Equation 2b)}$$

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 = \frac{(1)(2.33)}{3} + \frac{(2)(73.60)}{3} = 49.84, \qquad \text{(Equation 3b)}$$

$$s = \sqrt{s^2} = 7.06, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 7.06/\sqrt{9} = 2.35. \qquad \text{(Equation 5)}$$

6. The new value for $\bar{x}$ (93.56) is less than the RT (100). In addition, $\bar{x}$ is greater than s^2 (49.84) and, as previously indicated, the raw data are not characterized by obvious abnormality. Consequently, the study is continued, with the following calculation performed with nontransformed data.

7. $$CI = \bar{x} \pm t_{.20} s_{\bar{x}} = 93.56 \pm (1.397)(2.35) \qquad \text{(Equation 6)}$$

$$= 93.56 \pm 3.28.$$

The upper limit of the CI (96.84) is less than the applicable RT (100). Therefore, it is concluded that barium is not present in the sludge at a hazardous concentration.

BOX 3. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - SYSTEMATIC RANDOM SAMPLING

Step	General Procedure
1.	Follow general procedures presented for simple random sampling of solid wastes (Box 1).

Step	Hypothetical Example
1.	The example presented in Box 1 is applicable to systematic random sampling with the understanding that the nine sludge samples obtained from the lagoon would be collected at equal intervals along a transect running from a randomly selected location on one bank of the lagoon to the opposite bank. If that randomly selected transect were established between Units 1 and 409 of the sampling grid (Figure 2) and sampling were performed at Unit 1 and, thereafter, at three-unit intervals along the transect (i.e., Unit 1, Unit 52, Unit 103, . . . , and Unit 409), it is apparent that only two samples would be collected in the upper third of the lagoon, while seven samples would be obtained from the lower two-thirds of the lagoon. If, as suggested by the barium concentrations illustrated in Figure 2, the lower part of the lagoon is characterized by greater and more variable barium contamination than the upper part of the lagoon, systematic random sampling along the above-identified transect, by placing undue (disproportionate) emphasis on the lower part of the lagoon, might be expected to result in an inaccurate (overestimation) and imprecise characterization of barium levels in the whole lagoon, as compared to either simple random sampling or stratified random sampling. Such inaccuracy and imprecision, which is typical of systematic random sampling when unrecognized trends or cycles occur in the population, would be magnified if, for example, the randomly selected transect were established solely in the lower part of the lagoon, e.g., between Units 239 and 255 of the sampling grid.

1.1.4.1 Composite Sampling

In composite sampling, a number of random samples are initially collected from a waste and combined into a single sample, which is then analyzed for the chemical contaminants of concern. The major disadvantage of composite sampling as compared to noncomposite sampling is that information concerning the chemical contaminants is lost, i.e., each initial set of samples generates only a single estimate of the concentration of each contaminant. Consequently, since the number of analytical measurements (n) is small, $s_{\bar{x}}$ and $t_{.20}$ are large, thus decreasing the likelihood that a contaminant will be judged to occur in the waste at a nonhazardous level (refer to appropriate equations Table 1 and to Table 2). A remedy to that situation is to collect and analyze a relatively large number of composite samples, thereby offsetting the savings in analytical costs that are often associated with composite sampling, but achieving better representation of the waste than would occur with noncomposite sampling.

The appropriate number of composite samples to be collected from a solid waste is estimated by use of Equation 8 (Table 1) as previously described for the three basic sampling strategies. In comparison to noncomposite sampling, composite sampling may have the effect of minimizing between-sample variation (the same phenomenon that occurs when the physical size of a sample is maximized), thereby reducing somewhat the number of samples that must be collected from the waste.

1.1.4.2 Subsampling

The variance (s^2) associated with a chemical contaminant of a waste consists of two components in that:

$$s^2 = s_s^2 + \frac{s_a^2}{m}, \qquad \text{(Equation 12)}$$

with s_s^2 = a component attributable to sampling (sample) variation, s_a^2 = a component attributable to analytical (subsample) variation, and m = number of subsamples. In general, s_a^2 should not be allowed to exceed one-ninth of s_s^2. If a preliminary study indicates that s_a^2 exceeds that threshold, a sampling strategy involving subsampling should be considered. In such a strategy, a number of replicate measurements are randomly made on a relatively limited number of randomly collected samples. Consequently, analytical effort is allocated as a function of analytical variability. The efficiency of that general strategy in meeting regulatory objectives has already been demonstrated in the previous discussions of sampling effort.

The appropriate number of samples (n) to be collected from a solid waste for which subsampling will be employed is again estimated by Equation 8 (Table 1). In the case of simple random sampling or systematic random sampling with an equal number of subsamples analyzed per sample:

$$\bar{x} = \sum_{i=1}^{n} \bar{x}_i/n, \qquad \text{(Equation 13)}$$

with $\bar{x}_i$ = sample mean (calculated from values for subsamples) and n = number of samples. Also,

$$s^2 = \frac{\sum_{i=1}^{n} \bar{x}_i^2 - (\sum_{i=1}^{n} \bar{x}_i)^2/n}{n - 1}. \qquad \text{(Equation 14)}$$

The optimum number of subsamples to be taken from each sample ($m_{opt.}$) is estimated as:

$$m(\text{opt.}) = \frac{s_a}{s_s} \qquad \text{(Equation 15)}$$

when cost factors are not considered. The value for s_a is calculated from available data as:

$$s_a = \sqrt{\frac{\sum_{i=1}^{n} \sum_{j=1}^{m} X_{ij}^2 - (\Sigma X_{ij})^2/m}{n(m-1)}}, \qquad \text{(Equation 16)}$$

and s_s, which can have a negative characteristic, is defined as:

$$s_s = \sqrt{s^2 - \frac{s_a^2}{m}}, \qquad \text{(Equation 17)}$$

with s^2 calculated as indicated in Equation 14.

In the case of stratified random sampling with subsampling, critical formulas for estimating sample size (n) by Equation 8 (Table 1) are:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k, \qquad \text{(Equation 2b)}$$

with $\bar{x}_k$ = stratum mean and W_k = fraction of population represented by Stratum K (number of strata, k, ranges from 1 to r). In Equation 2b, $\bar{x}_k$ for each stratum is calculated as the average of all sample means in the stratum (sample means are calculated from values for subsamples). In addition:

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 , \qquad \text{(Equation 3b)}$$

with s_k^2 for each stratum calculated from all sample means in the stratum. The optimum subsampling effort when cost factors are not considered and all replication is symmetrical is again estimated as:

$$m_{(opt.)} = \frac{s_a}{s_s} \text{ , with} \qquad \text{(Equation 15)}$$

$$s_a = \sqrt{\frac{\sum_{k=1}^{r} \sum_{i=1}^{n} \sum_{j=1}^{m} X_{kij}^2 - (\Sigma X_{kij})^2/m}{rn\,(m-1)}} \text{ , and} \qquad \text{(Equation 18)}$$

$$s_s = \sqrt{s^2 - \frac{s_a^2}{m}} , \qquad \text{(Equation 17)}$$

with s^2 derived as shown in Equation 3b.

1.1.4.3 Cost and Loss Functions

The cost of chemically characterizing a waste is dependent on the specific strategy that is employed to sample the waste. For example, in the case of simple random sampling without subsampling, a reasonable cost function might be:

$$C_{(n)} = C_o + C_1 n , \qquad \text{(Equation 19)}$$

with $C_{(n)}$ = cost of employing a sample size of n, C_o = an overhead cost (which is independent of the number of samples that are collected and analyzed), and C_1 = a sample-dependent cost. A consideration of $C_{(n)}$ mandates an evaluation of $L_{(n)}$, which is the sample-size-dependent expected financial loss related to the erroneous conclusion that a waste is hazardous. A simple loss function is:

$$L_{(n)} = \frac{\alpha s^2}{n}, \qquad \text{(Equation 20)}$$

with α = a constant related to the cost of a waste management program if the waste is judged to be hazardous, s^2 = sample variance, and n = number of samples. A primary objective of any sampling strategy is to minimize $C_{(n)} + L_{(n)}$. Differentiation of Equations 19 and 20 indicates that the number of samples (n) which minimize $C_{(n)} + L_{(n)}$ is:

$$n = \sqrt{\frac{\alpha s^2}{C_1}}. \qquad \text{(Equation 21)}$$

As is evident from Equation 21, a comparatively large number of samples (n) is justified if the value of α or s^2 is large, whereas a relatively small number of samples is appropriate if the value of C_1 is large. These general conclusions are valid for any sampling strategy for a solid waste.

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7445-03-014

April 5, 1990

OH Materials
4 Research Way
Princeton, NJ 08540
c/o Chris Zwiebel

Re: Tonolli Water Results

Sampled By : C.Z.

RESULTS

Parameter	System Influent	System Effluent	Methodology
Lead - Total (mg/l)	3.08	0.016	EPA No. 239.1
Lead - Dissolved (mg/l)	1.61	0.012	EPA No. 239.1
Copper - Total (mg/l)	0.041	0.010	EPA No. 220.2
Copper - Dissolved (mg/l)	0.028	<0.001	EPA No. 220.2
Iron - Dissolved (mg/l)	0.027	<0.005	EPA No. 236.1
Antimony (mg/l)	0.161	0.081	EPA No. 204.2
Beryllium (mg/l)	0.010	<0.005	EPA No. 210.2
Cadmium (mg/l)	0.036	0.017	EPA No. 213.2
Silver (mg/l)	0.0015	<0.0005	EPA No. 272.2
Tin (mg/l)	0.013	0.005	EPA No. 282.2
Zinc (mg/l)	0.27	0.073	EPA No. 289.1

Date Sampled	4/2/90	4/2/90
Time Sampled	1055	1100
Sample No.	8839	8840

Michael L. Klusaritz
Laboratory Director
HESS ENVIRONMENTAL LABORATORIES

APR 10 1990

A Division of R.K.R. Hess Associates

MLK/dm

APPENDIX J

RANDOM SAMPLING FOR METALS BENEATH THE LAGOON LINER

ORIGINAL (Red)

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TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE REMOVAL AND PREVENTION
EPA CONTRACT 68-01-7367

MEMORANDUM

TO: Rich Fetzer, OSC, EPA Region III
Eastern Response Section

THRU: Mike Zickler, TATL, Region III MZ TDD #8910-10
PCS #2693

THRU: Bhupi Khona, RSO, Region III BK

FROM: S. Andrew Sochanski, TAT Region III SAS

SUBJECT: Tonolli Site
Random Sampling for Metals
Beneath the Onsite Lagoon Liner

DATE: October 17, 1989

INTRODUCTION

A random sampling procedure was instituted to determine the extent and degree of subsurface (soil/sediment) contamination beneath the onsite lagoon liner at the Tonolli CERCLA Removal Site, Nesquehoning, Carbon County, Pennsylvania. The liner of the lagoon was in a poor condition and therefore, subsurface contamination was expected.

The objective of a random sampling plan is to collect a sufficient number of samples that represent the chemical contamination (wastes) precisely and accurately. Sampling accuracy is based upon the statistical measurement of the mean ($\bar{X}$), dispersion or standard deviation (S), variance of the sample (S^2), the standard error ($S_{\bar{X}}$) and the Confidence Interval (CI). When these statistical requirements are determined to be accurate, the upper limit of the

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ORIGINAL (Red)

STATISTICAL REQUIREMENTS FOR A RANDOM SAMPLING PLAN

X - Endrin variable of concentration

X_i - Individual measurement

RT - Regulatory Threshold for lead (500 ppm)

$\bar{X}$ - Mean measurements generated by the sample results.

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Where n = number of sample measurements

Sample Variance

$$S^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)\ 2/n}{n-1}$$

$$S = \sqrt{S^2}$$

$$S_{\bar{x}} = \frac{S}{\sqrt{n}}$$

$$n = \frac{t^2\ .20}{\Delta^2}S^2 \qquad \Delta = RT - \bar{X}$$

STATISTICAL ANALYTICAL RESULTS

CASE 1: Lead concentration in the soil/sediments beneath the liner of the lagoon.

$\bar{X}$ = 7,748 ppm (lead) - mean value for the five random results.

$\bar{X} \geq$ RT (500 ppm) Therefore, a hazard is present due to the contaminated material (sediments/soils).

Sample Variance - is calculated to determine the appropriate number of samples to validate the analytical.

$S^2 = 7.5 \times 10^7$

$S = \sqrt{S^2} = 8661$

$S_{\bar{x}} = \frac{S}{\sqrt{n}} = 3,873.5$

CI is compared to the Regulatory Threshold (RT) for each contaminant of concern. When the upper limit of the CI is less than the regulatory threshold, the contaminant is considered not to be present at a hazardous level and the study is complete (See Sampling of Solid Wastes, EPA SW-846).

BACKGROUND

The random sampling procedure was adopted to determine the degree and extent of the contamination beneath the lagoon liner. Initially five random sample locations were selected beneath the liner of the onsite lagoon. The result of the random sampling was statistically checked for variance and mean calculations to validate the initial sampling.

A sampling flow chart was developed with the following criteria. If two of the five random sample locations had concentrations of lead which were greater than 500 parts per million (ppm), excavation was necessary to remove the contaminated soil/sediments. Furthermore, if the average contamination for lead was greater than or equal to 2,000 ppm, excavation would also be necessary (See Tonolli Sampling Flow Chart).

ANALYTICAL RESULTS

CASE 1: Subsurface soil/sediments beneath the onsite lagoon liner.

Sample Number	Lead (ppm)
#137	2,150
#138	19,300
#139	15,600
#140	1,030
#142	660
#141 (Background)	190

CASE 2: Clay layer beneath the onsite lagoon at a depth of two to four inches into the clay liner.

Sample Number	Lead (ppm)
#144	153
#145	10.3
#146	9.67
#147	18.7
#148	7.72
#141 (Background)	190

ANALYSIS REPORT

Lancaster Laboratories Incorporated

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

ORIGINAL (Red)

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN01 37 mm Filter Tonolli
Bldg D 35' from West Wall 18' from South Wall
Sampled 9/1/89 (1602) by DK

LLI Sample No. AQ 1434014

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	26.	ug	2.	040101300S
Lead Duplicate	28.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101376

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. AQ 1434021

ORIGINAL (Red)

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN Blank 37 mm Filter Tonolli

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	< 2.	ug	2.	040101300S
Lead Duplicate	< 2.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101372

ORIGINAL (Red)

APPENDIX G

REGION III INCIDENT NOTIFICATION REPORT

ORIGINAL (Red)

DELIVERY ORDER FOR EMERGENCY RESPONSE CLEANUP SERVICES

ORIGINAL (Red)

(This delivery order is issued subject to all terms and conditions of the contract identified in Block 2.)

1. DATE OF ORDER	2. CONTRACT NUMBER	3. ORDER NUMBER
10-13-87	68-01-7445	744503014

4. TIME OF INITIAL ORDER *(If initial order was verbal) (Specify Time Zone)*
☐ AM ☒ PM
1400 est

5. DELIVERY ORDER CEILING AMOUNT *(Obligated Amount)*
$100,000

6. ACCOUNTING AND APPROPRIATION DATA

Appropriation Number	Document Control No.	Account Number	Object Class
68/20/8145	KV 0010	8TFA3AS[illegible]	[illegible]

7a. ISSUED TO: CONTRACTOR *(Name, Address, and ZIP Code)*
OH Materials Company
16406 US Route 224 East
Findlay, OH 45839

8a. ISSUED BY: ORDERING OFFICE *(Name, Address, and ZIP Code)*
US Environmental Protection Agency
Region III
303 Methodist Building
Wheeling, WV 26003

7b. PROGRAM MANAGER *(Name and Phone Number)*
John Copus, (800)338-4508

8b. EPA REGION/USCG DISTRICT
Region III

8c. ZONE
I

7c. RESPONSE MANAGER *(Name and Phone Number)*

8d. ON-SCENE COORDINATOR *(Name and Phone Number)*
Jerry Saseen (304)[illegible]-9831

9. RESPONSE LOCATION *(Site Name and/or Address and ZIP Code)*
Tonolli Corp. Site
Nesquehoning, Carbon Co. Pa.

10. CONTRACTOR REQUIRED ON SITE *(Date and Time) (Specify Time Zone)*
10-19-87 1400 est ☐ AM ☐ PM

11. REQUIRED WORK COMPLETION DATE
10-19-88

12. STATEMENT OF WORK

The Contractor shall furnish the necessary personnel, materials, services, facilities, and otherwise do all things necessary for or incident to the performance of the work set forth below:

Response manager to mobilize to the site October 19, 1987 to set site work schedule, with the on scene co-ordinator. Upon notification of the OSC, mobilize crews to the site to initiate cleanup.

13. ORDERING OFFICER

NAME/TITLE	SIGNATURE	DATE
On-Scene Coordinator	[signature]	10-13-87

ORDERING OFFICER/OSC

AR101374

EPA Form 1900-59 (11-83) ☆ U.S. GPO 1983—426-222/364

AR101374

ORIGINAL (Red)

APPENDIX F

DELIVERY ORDER

ANALYSIS REPOR

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
Matrix Spike Dup. of Blank Wipe Sample 091889TNWOD

ORIGINAL (Red)

Date Reported 9/26/
Date Submitted 9/21/
Discard Date 10/27/
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB
Lead		see below		0401(
Spike recovery	106.	%		

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories
Reviewed and Approved

Jack T. Follweiler,
Group Ldr., Industr

01376

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNWOD Blank Wipe Sample Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 10.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101377

Lancaster Laboratories INCORPORATED
2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

LLI Sample No. HQ 1456810

ORIGINAL (Red)

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
Matrix Spike of Blank Wipe Sample 091889TNWOD

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead		see below		040101300S*
Spike recovery	100.	%		

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

AR101378

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follveiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW03 Wipe Sample Entrance Wall Near
Receptionist Window 9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	1,130.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

The American Association for Laboratory Accreditation Chemical, Biological & Environmental fields of testing.

Member: American Council of

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
033 03182 13.00 002600

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101379

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED
[illegible] Lancaster, PA 17601-5994 (717) 656-2301

Lab Sample No. HQ [illegible]

Date Reported	9/26/89
Date Submitted	9/21/89
Discard Date	10/27/89
Collected by	C
P.O.	TONOLLI
Rel.	

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW04 Wipe Sample Lunch Room Proposed Wall
Near Window 9/18/89 Tonolli

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	190.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

AR101380

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW01 Wipe Sample Proposed Lunch Room Floor
9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	27,100.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

ORIGINAL

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TNW02 Wipe Sample Entrance Floor
9/18/89 Tonolli

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	43,100.	ug	10.	040101300S*

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
033 03182 13.00 002600

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

01382

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

020 D 1 13

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN04 37 mm Filter Bange Tonolli
9/18/89
382 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	6.	ug	2.	040101300S*
Lead Confirmation	5.	ug	2.	900101300S
Lead in Air	8.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101383

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

ORIGINAL Red

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

091889TN05 37 mm Filter RT Hall Personal Tonolli
9/18/89
97 min @ 2 lpm

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	3.	ug	2.	040101300S*
Lead Confirmation	3.	ug	2.	900101300S
Lead in Air	15.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

384

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

091889TN02 37 mm Filter Filter Press Tonolli
9/18/89
402 min @ 2 lpm

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 2.	ug	2.	040101300S*
Lead Confirmation	< 2.	ug	2.	900101300S
Lead in Air	< 2.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

091889TN03 37 mm Filter Mixing Tank Tonolli
9/18/89
386 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	3.	ug	2.	040101300S*
Lead Confirmation	3.	ug	2.	900101300S
Lead in Air	4.	ug/m3	2.	900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3.

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101386

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN00 37 mm Filter BLANK Tonolli
9/18/89

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	< 2.	ug	2.	040101300S*
Lead Confirmation	< 2.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 003900

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ORIGINAL

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
091889TN01 37 mm Filter Command Post Tonolli
9/18/89
394 min @ 2 lpm

Date Reported 9/26/89
Date Submitted 9/21/89
Discard Date 10/27/89
Collected by C
P.O. TONOLLI
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Lead	4.	ug	2.	040101300S*
Lead Confirmation	4.	ug	2.	900101300S
Lead in Air	5.	ug/m3		900200500S

Occupational Safety and Health Administration 8-hour Permissible Exposure Limit for lead: 50 ug/m3

4043/85.

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
033 03182 13.00 004400

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

...d Pike, Lancaster, PA 17601 ... (717) 656-2301

LLI Sample No. AQ 1434019

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN06 37 mm Filter Tonolli
Personal Air Sampling Attached RT
Sampled 9/1/89 (1545) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	9.	ug	2.	040101300S
Lead Duplicate	10.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

LLI Sample No. AQ 1434020

ORIGINAL

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN07 37 mm Filter Tonolli
Mud/Mix Tank Adj. to Lagoon
Sampled 9/1/89 (1525) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	180.	ug	2.	040101300S
Lead Duplicate	204.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

AR101390

Questions? Contact Industrial Hygiene
Technical Services at (717) 295-2507
080 03182 -13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Kohlweiler, B.S.
Group Ldr., Industrial Hygiene

AR101390

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

PA 17601-5994 (717) 656-2301

LLI Sample No. AQ 1434017

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

TN04 37 mm Filter Tonolli
Front Loader Cabin Upper Left Corner
Sampled 9/1/89 (1515) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	19.	ug	2.	040101300S
Lead Duplicate	21.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

See Reverse Side For Explanation Of Symbols And Abbreviations And Our Standard Terms And Conditions

AR101391

ANALYSIS REPORT

Lancaster Laboratories

INCORPORATED

LLI Sample No. AQ 1434018

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN05 37 mm Filter Tonolli
Air Conditioner on West Side of Corner Post
Sampled 9/1/89 (1508) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	3.	ug	2.	040101300S
Lead Duplicate	3.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follveiler, B.S.
Group Ldr., Industrial Hygiene

AR101392

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 • (717) 656-2301

LLI Sample No. AQ 1434015

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453

TN02 37 mm Filter Tonolli
1/2' from West Wall 25' from South Wall Bldg D
Sampled 9/1/89 (1556) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ORIGINAL (Red)

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	60.	ug	2.	040101300S
Lead Duplicate	63.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Kolweiler, B.S.
Group Ldr., Industrial Hygiene

AR101393

AR101393

ANALYSIS REPORT

Lancaster Laboratories INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601-5994 · (717) 656-2301

ORIGINAL (Red)

LLI Sample No. AQ 1434016

Roy F. Weston, Inc.-NJ
SPER Division
53 Haddonfield Road, Suite 306
Cherry Hill, NJ 08002-1453
TN03 37 mm Filter Tonolli
75' from West Wall 50' from South Wall Bldg D
Sampled 9/1/89 (1605) by DK

Date Reported 9/15/89
Date Submitted 9/12/89
Discard Date 10/16/89
Collected by C
P.O. 2536
Rel.

ANALYSIS	RESULT AS RECEIVED		LIMIT OF QUANTITATION	LAB CODE
Arsenic	< 2.	ug	2.	039503300S
Lead	25.	ug	2.	040101300S
Lead Duplicate	27.	ug	2.	900101300S

1 COPY TO Roy F. Weston, Inc.-NJ ATTN: Mr. Bhupi Khona

Questions? Contact Industrial Hygiene Technical Services at (717) 295-2507
080 03182 13.00 007200

Respectfully Submitted
Lancaster Laboratories, Inc.
Reviewed and Approved by:

Jack T. Follweiler, B.S.
Group Ldr., Industrial Hygiene

AR101394

In CASE 1, n = 3.35 the number of required samples to show that a hazard is present in the sediments beneath the liner of the lagoon. Therefore, the minimum number of samples that are required to characterize the contamination beneath the lagoon liner is four (n=3.35). Then, four samples are the least number of samples to be collected to sufficently estimate the true mean (u) concentration for lead.

CASE 2: Lead contamination in the clay liner beneath the soil/sediments in case 1.

$\bar{X}$ = 39.87 ppm (lead)

$\bar{X} \leq$ RT (500 ppm) No hazard is present

Sample Variance

$S^2 = 3966.8$

$S = \sqrt{S^2} = 62.98$

$S_{\bar{X}} = \frac{S}{\sqrt{n}} = 28.16$

$\bar{X}$ is less than S^2

39.87 < 3966.0 (negative binomial distribution)

Conclusion

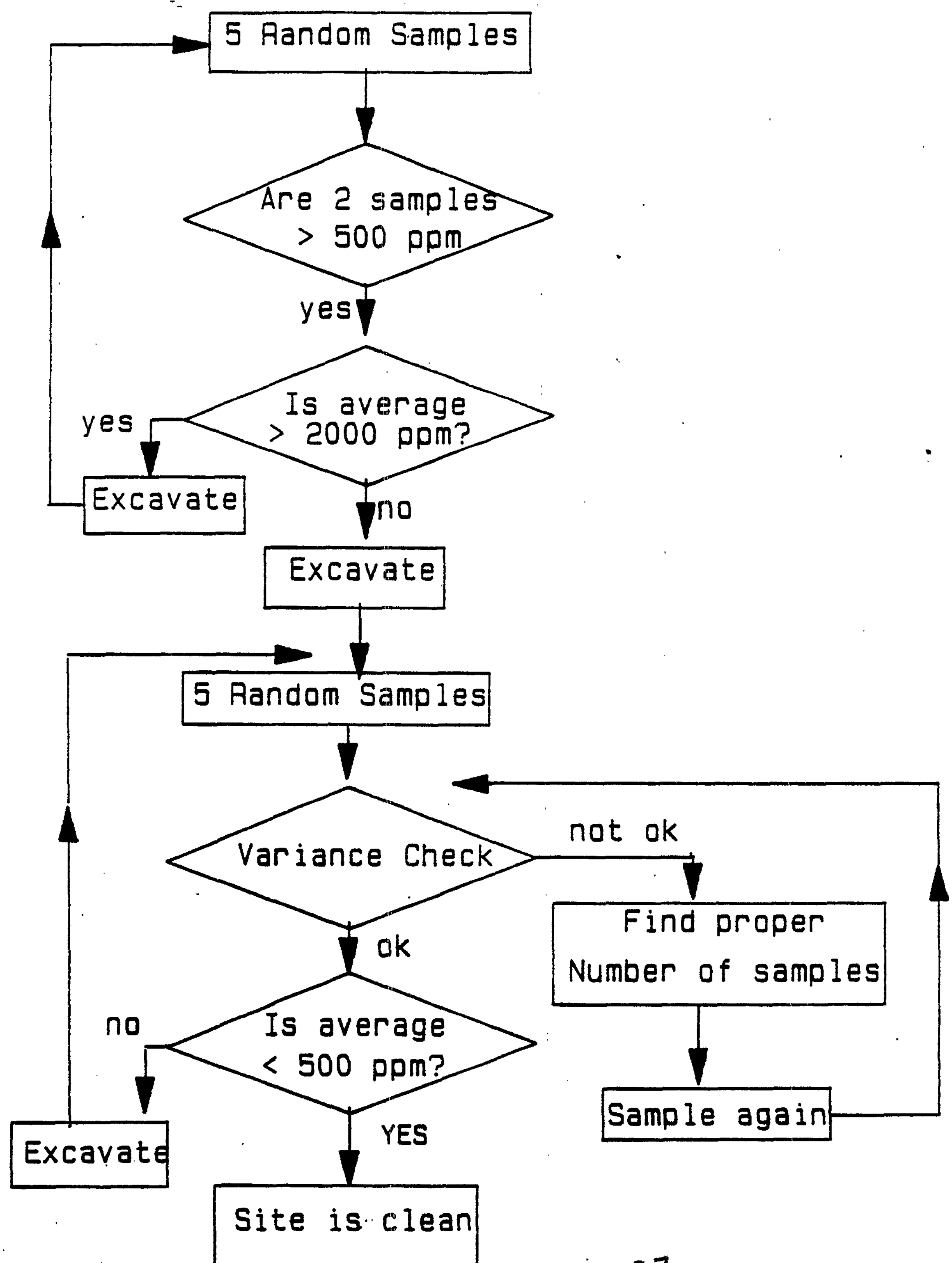
The random sampling plan developed for the Tonolli Removal Site generated adequate data to determine the extent and depth to which lead contamination existed beneath the liner of the lagoon. In Case 1, the mean value $\bar{X}$ is 7,748 ppm which is greater than the regulatory threshold (500 ppm for lead). The calculated confidence interval (CI) is 7,748 ppm ± (5,938). Since both values of CI are greater than the regulatory threshold, it is confident that lead contamination is present.

In Case 2 (clay layer), the mean value $\bar{X}$ is 39.87 ppm which is less than the regulatory threshold (500 ppm for lead). This suggests that no lead contamination exists at a hazardous concentration in the clay layer. To further validate the analytical results, the confidence interval (CI) is calculated. In Case 2, the CI is equal to 39.87 ± 43.45 ppm of lead. Both values for CI (-3.29 or 83.32) are less than the regulatory threshold and it can be stated that the amount of lead contamination in the clay layer is considered to be below the hazardous concentration level.

The clay layer was found to be not contaminated at a hazardous level for lead, although the material (sediments/soil) that was above the clay layer was found to be contaminated (greater than 500 ppm concentration of lead). Therefore, excavation was necessary to remove the contaminated material (sediment/soils) just to the depth of the clay layer beneath the onsite lagoon.

AS/tl
Enclosures: Tonolli Sampling Flow Chart - 1 page
Tonolli Site Random Sample Locations - 1 page
Sampling of Solid Waste - 26 pages

TONOLLI SAMPLING FLOW CHART



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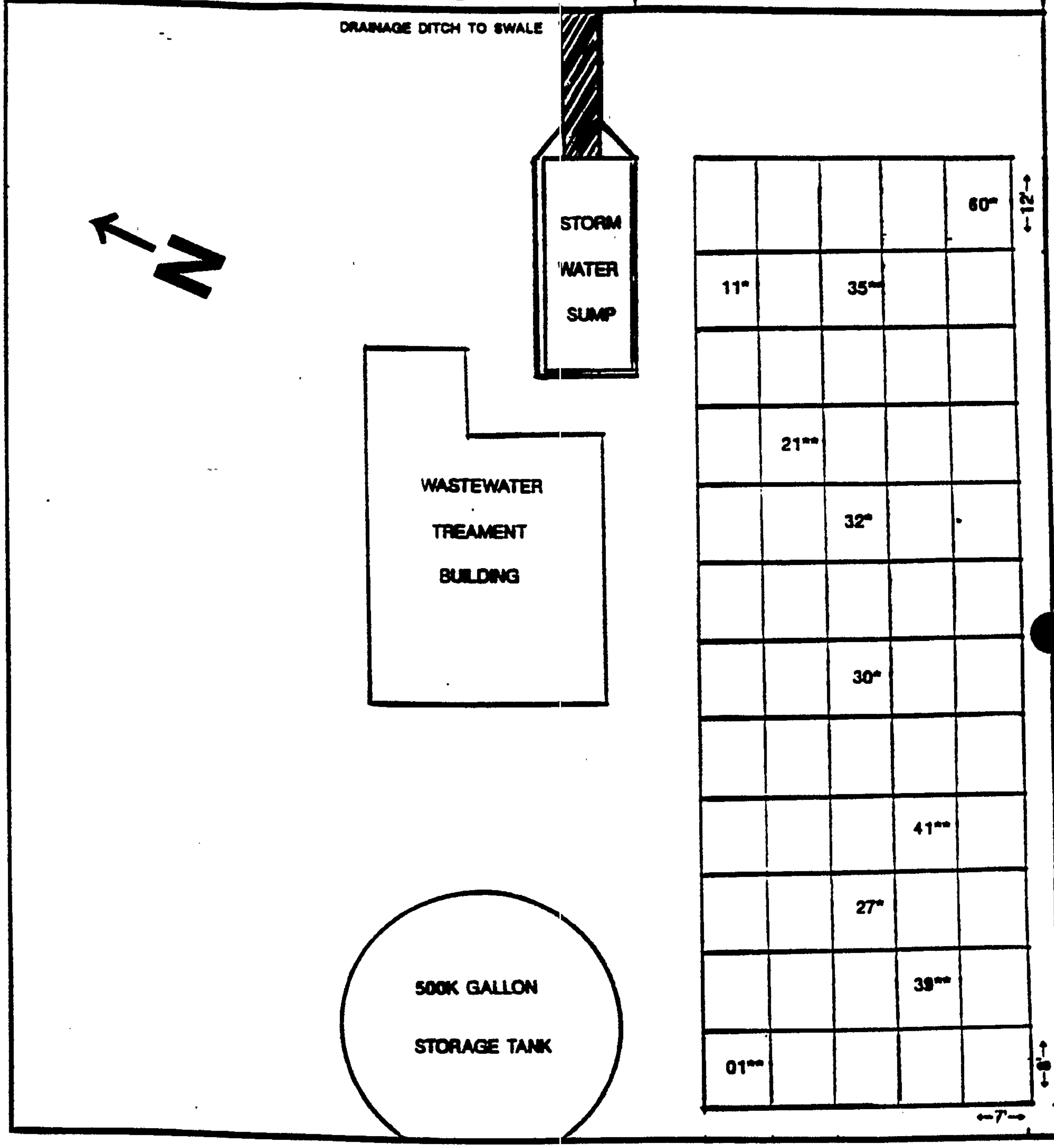
TDD Number: 8910-10A
PCS Number: 2776



LAGOON BOTTOM DIMENSIONS 35' x 100'
★ NOT TO SCALE ★

* = 10/05/89 SAMPLING
** = 10/06/89 SAMPLING

LAGOON RANDOM SAMPLING LOCATIONS

TONOLLI CORPORATION SITE

NESQUEHONING, CARBON COUNTY, PENNSYLVANIA

AR101398

11/07/89

TEST METHODS FOR EVALUATING SOLID WASTE

—Physical/Chemical Methods—

SW-846

Second Edition

Revised

U.S. ENVIRONMENTAL PROTECTION AGENCY

APRIL 1984

TEST METHODS FOR EVALUATING SOLID WASTE

—Physical/Chemical Methods—

- Instructions for Replacement Pages, April 1984 revision -

The enclosed are replacement pages for TEST METHODS FOR EVALUATING SOLID WASTE - PHYSICAL AND CHEMICAL METHODS. Sides of the page where revisions have been made are marked "Revised 4/84".

Methods are arranged in the manual in numerical order and are paginated within each method. No individual page number refers to placement in the book as a whole. That is, "5030 / 3" on the top of a page indicates that page is page 3 of Method 5030.

Text pages are divided into sections using the weighted decimal point system. Page numbers refer to that page within a particular section.

Replace old copies of pages with the new updated ones.

ORIGINAL (Red)

PREFACE

This second edition of "Test Methods for Evaluating Solid Waste" contains the procedures that may be used by the regulated community or others in order to determine whether a waste is a hazardous waste as defined by regulations promulgated under Section 3001 of the Resource Conservation and Recovery Act (RCRA, PL 94-580 (40 CFR Part 261). The manual provides methodology for collecting representative samples of the waste, and for determining the ignitability, corrosivity, reactivity, Extraction Procedure (EP) Toxicity and composition of the waste.

This document has been developed to:

a. provide methods which will be acceptable to the Agency when used by the regulated community to support waste evaluations and listing and delisting petitions, and

b. describe the methods that will be used by the Agency in conducting investigations under Section 3001, 3007, and 3008.

The practice of evaluating solid wastes for environmental and human health hazards is new. Experience has only recently accumulated in analyzing wastes for inorganic and organic species, and for intrinsic properties such as pH, flash point, reactivity and leachability. This manual will serve as a compilation of state-of-the-art methodology for conducting such tests. It is meant to be a dynamic document. The methodology descriptions will be frequently updated and expanded in order to keep pace with the developments being achieved by EPA, the regulated community, and others.

Standardized approved methods must be available so that the regulated community can be certain that the data it provides will be acceptable to the Agency. This manual thus makes available to the regulated community and others, those methods that the Agency considers suitable.

Many of the methods presented in this manual have not been fully evaluated by the Agency using materials characteristic of the wastes regulated under RCRA. Such evaluations are underway. However, until such time as the methods in this manual are superseded, the Agency will accept data obtained by the test methods presented in this manual. Only those data that are obtained when Quality Control and Quality Assurance procedures are followed by the testing organization will be accepted by the Agency.

This manual will eventually include a second part comprised of biological methods for determining toxic properties of RCRA wastes. Such toxic properties may include carcinogenicity, mutagenicity, teratogenicity, aquatic toxicity, phytotoxicity, and mammalian toxicity.

Methods will be provided in this present volume for the following specific areas:

a. design of sampling and evaluation plans;

b. collection of samples from various types of environments (e.g., pipes, drums, pits, ponds, piles, tanks);

c. transportation and storage of samples;

d. chain-of custody considerations to insure defensibility of data;

e. determination of the pH, corrosivity to steel, flash point, and explosivity;

f. conduct of the Extraction Procedure;

g. analysis of wastes and extracts for organic and inorganic constituents;

h. safety in solid waste sampling and testing, and

i. quality control and quality assurance.

The analytical and sampling methods presented in this manual have been derived from a number of published sources, chiefly:

a. "Methods for the Evaluation of Water and Wastewater," EPA-600/4-79-020, U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268,

b. "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water an Wastewater," U.S. EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268, September 1978,

c. Guidelines Establishing Test Procedures for the Analysis of Pollutants; Proposed Regulations; 44 FR 69464-69575, and

d. "Samplers and Sampling Procedures for Hazardous Waste Streams," EPA-600/2-80-018, U.S. EPA, Municipal Environmental Research Laboratory, Cincinnati, OH 45268.

In addition, work conducted by and the assistance of scientists of the Environmental Monitoring Systems Laboratory at Las Vegas, NV, the Environmental Research Laboratory at Athens, GA, and the National Enforcement Investigations Center at Denver, CO, is gratefully acknowledged and appreciated.

Although a sincere effort has been made to select methods that are applicable to the widest range of expected wastes, significant interferences, or other problems, may be encountered with certain samples. In these situations, the analyst is advised to contact the Manager, Waste Analysis Program (WH-565), Waste Characterization Branch, Office of Solid Waste, Washington, D.C. 20460 (202-755-9187) for assistance. The manual is intended to serve all those with a need to evaluate solid waste. Your comments, corrections, suggestions, and questions concerning any material contained in, or omitted from, this manual will be gratefully appreciated. Please direct your comments to the above address.

ORIGINAL (Red)

TABLE OF CONTENTS[1]

[1]Section and method numbers from the first edition of this manual are given in brackets, and are also listed in the Conversion Table following this Table of Contents.

[2]To ensure that future additions and deletions of material can be made without disruption, the manual's pages are not numbered sequentially. Section numbers are given with the page number. Actual methods are numbered sequentially within themselves. Revised pages are noted as such in the bottom corner of the page.

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SECTION ONE	SAMPLING OF SOLID WASTES (Continued)	
	1.2.1.2 Weighted Bottle	
	1.2.1.3 Dipper	
	1.2.1.4 Thief	
	1.2.1.5 Trier	
	1.2.1.6 Auger	
	1.2.1.7 Scoop and Shovel	
	1.2.2 Selection of Sample Containers	Containers
	1.2.3 Processing and Storage of Samples	Processing
1.3	Documentation of Chain of Custody [Section 2]	Chain of Custody
	1.3.1 Sample Labels	Labels
	1.3.2 Sample Seals	Seals
	1.3.3 Field Log Book	Log Book
	1.3.4 Chain-of-Custody Record	Record
	1.3.5 Sample Analysis Request Sheet	Request
	1.3.6 Sample Delivery to the Laboratory	Delivery
	1.3.7 Shipping of Samples	Shipping
	1.3.8 Receipt and Logging of Sample	Receipt
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1.4	Sampling Methodology [Section 3]	Methodology
	1.4.1 Containers	Containers
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	1.4.3 Waste Piles	Waste Piles
	1.4.4 Landfills and Lagoons	Landfills
SECTION TWO	WASTE EVALUATION PROCEDURES	EVALUATION
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	Introduction	Introduction
	Regulatory Definition	Regulatory Definition
	Pensky-Martens Closed-Cup Method	1010
	Setaflash Closed-Cup Method	1020
	2.1.2 Corrosivity [Section 5]	Corrosivity
	Introduction	Introduction
	Regulatory Definition	Regulatory Definition
	Corrosivity Toward Steel	1110

ORIGINAL (Red)

SECTION/METHOD

SECTION SEVEN INORGANIC ANALYTICAL METHODS (Continued)

ACKNOWLEDGMENT

The Office of Solid Waste would like especially to thank the following individuals and groups for the help and advice they gave us during the preparation of this manual:

U.S. Environmental Protection Agency, Inductively Coupled Plasma Users Group

Dr. Theodore Martin and Dr. Gerald McKey, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio

Dr. John Warren, U.S. Environmental Protection Agency, Regulations and Standards Division, Washington, D.C.

Dr. John Maney, Dr. Curt Rose, Ann Soule, Jan Connery, Ann Gordon, Dr. Dallas Wait, Dr. Tyrone Smith, Scott Drew, and George Perry of Energy Resources Company, Inc., Cambridge, Massachusetts.

We would also like to thank the Environmental Protection Agency's Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, for providing the basic methodology used in this manual.

ORIGINAL (Red)

CONVERSION TABLE

The sections and methods of the first edition of this manual are given on the lefthand side of the page, and the location of their replacements is given on the righthand side.

First Edition		Current (Second) Edition
1.0	Evaluation Plan Design	Section 1.0
2.0	Chain of Custody Procedures	Section 1.3
3.0	Sampling Methodology	Section 1.4
3.1	Sampling Plan Design	Section 1.1
3.2	Sampling Equipment	Section 1.2.1
3.3	Sample Containers	Section 1.4.1
3.4	Sampling Handling & Preservation	Section 1.3; also see individual method
4.0	Ignitability	Section 2.1.1
5.0	Corrosivity	Section 2.1.2
5.2	pH Measurement	Methods 9040, 9041, 9045
6.0	Reactivity	Section 2.1.3
7.0	Extraction Procedure Toxicity (EP Tox)	Section 2.1.4
8.0	Analytical Methodology	8000 series of methods
	Gas Chromatographic Methods	8000, 8100 series of methods
8.01	Volatile organics, general	Methods 8010, 8015, 8020
8.02	Volatile aromatics, selected ketones and ethers	Method 8090
8.03	Acrolein, Acrylonitrile and Acetonitrile	Method 8030
8.04	Phenols	
8.06	Semi-volatile organics	Method 8040
8.08	Organochlorine pesticides and PCBs	Method 8060
8.09	Nitroaromatics	Method 8080
8.10	Polynuclear Aromatic Hydrocarbons	Method 8090
8.12	Semi-volatile chlorinated hydrocarbons	Methods 8100, 8310
		Method 8120
8.22	Organophosphorus pesticides	Method 8140
8.40	Chlorophenoxy acid pesticides	Method 8150

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First Edition	Current (Second) Edition
Gas Chromatographic/Mass Spectroscopy Methods	8200 series of methods
8.24 Volatile organics	Method 8240
8.25 Semi-volatile organics	Method 8250
8.27 Capillary Column GC/MS Method for the Analysis of Wastes	Method 8270
High Performance Liquid Chromatographic Methods	8300 series of methods
8.30 Polynuclear Aromatic Hydrocarbons (see method 8.10)	Method 8310
Atomic Absorption Spectrographic Methods	7000 series of methods
8.49 General Requirements	
8.50 Antimony	Methods 7040, 7041
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8.52 Barium	Methods 7080, 7081
8.53 Cadmium	Methods 7090, 7091
8.54 Chromium	Methods 7190, 7191
8.545 Hexavalent chromium: Coprecipitation	Method 7195
8.546 Hexavalent chromium: Colorimetric	Method 7196
8.547 Hexavalent chromium: Chelation-Extraction	Method 7197
8.548 Alkaline Digestate	Method 3060
8.55 Cyanide	Method 9010
8.56 Lead	Methods 7420, 7421
8.57 Mercury	Methods 7470, 7471
8.58 Nickel	Methods 7520, 7521
8.59 Selenium	Methods 7740, 7741
8.60 Silver	Methods 7760, 7761
Other Measurement Methods	9000 series of methods
8.55 Titrimetric Method for Cyanide	Method 9010
8.56 Microcoulometric Method for Total Organic Halide	Method 9020
8.57 Titrimetric Method for Sulfides	Method 9030
Sample Preparation/Introduction Techniques	Sections 4 and 5
8.82 Headspace	Method 5020
8.83 Purge and Trap	Method 5030
8.84 Shake Out	Method 3510
8.85 Sonication	Method 3550
8.86 Soxhlet Extraction	Method 3540

First Edition	Current (Second) Edition
9.0 Interference Removal Procedures	See individual method
9.01 Liquid-Liquid Extraction	Method 3520
10.0 Quality Control/Quality Assurance	Section 10
11.0 Suppliers	See individual method

SECTION ONE

SAMPLING OF SOLID WASTES

The initial and perhaps most critical element in a program designed to evaluate the physical and chemical properties of a solid waste is the plan for sampling the waste. It is understandable that analytical studies, with their sophisticated instrumentation and high cost, are often perceived as the dominant element in a waste characterization program. Yet, despite that sophistication and high cost, analytical data generated by a scientifically defective sampling plan have limited utility, particularly in the case of regulatory proceedings.

This section of the manual addresses the development and implementation of a scientifically credible sampling plan for a solid waste and the documentation of the chain of custody for such a plan. The information presented in this section is relevant to the sampling of any solid waste, which has been defined by the EPA in its regulations for the identification and listing of hazardous wastes to include solid, semisolid, liquid, and contained gaseous materials. However, the physical and chemical diversity of those materials, as well as the dissimilar storage facilities (lagoons, open piles, tanks, drums, etc.) and sampling equipment associated with them, preclude a detailed consideration of any specific sampling plan. Consequently, since the burden of responsibility for developing a technically sound sampling plan rests with the waste producer, it is advisable that he seek competent advice before designing a plan. This is particularly true in the early developmental stages of a sampling plan, which require at least a basic understanding of applied statistics. Applied statistics is the science of employing techniques that allow the uncertainty of inductive inferences (general conclusions based on partial knowledge) to be evaluated.

1.1 Development of Appropriate Sampling Plans

An appropriate sampling plan for a solid waste must be responsive to both regulatory and scientific objectives. Once those objectives have been clearly identified, a suitable sampling strategy, predicated upon fundamental statistical concepts, can be developed. The statistical terminology associated with those concepts is reviewed in Table 1.

1.1.1 Regulatory and Scientific Objectives

The EPA, in its hazardous waste management system, has required that certain solid wastes be analyzed for physical and chemical properties. It is mostly chemical properties that are of concern, and, in the case of a number of chemical contaminants, the EPA has promulgated levels (regulatory thresholds) that cannot be equaled or exceeded. The regulations pertaining to the

TABLE 1. --BASIC STATISTICAL TERMINOLOGY APPLICABLE TO SAMPLING PLANS FOR SOLID WASTES

Terminology	Symbol	Mathematical equation	(Equation)
• Variable (e.g., barium or endrin)	X	---	
• Individual measurement of variable	X_i	---	
• Mean of all possible measurements of variable (population mean)	μ	$\mu = \frac{\sum_{i=1}^{N} X_i}{N}$, with N = number of possible measurements	(1)
• Mean of measurements generated by sample (sample mean)	$\bar{x}$	<u>Simple random sampling and systematic random sampling</u> $\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n}$, with n = number of sample measurements	(2a)
		<u>Stratified random sampling</u> $\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k$, with $\bar{x}_k$ = stratum mean and W_k = fraction of population represented by Stratum k (number of strata [k] ranges from 1 to r)	(2b)
• Variance of sample	s^2	<u>Simple random sampling and systematic random sampling</u> $s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1}$	(3a)
		<u>Stratified random sampling</u> $s^2 = \sum_{k=1}^{r} W_k s_k^2$, with s_k^2 = stratum variance and W_k = fraction of population represented by Stratum k (number of strata [k] ranges from 1 to r)	(3b)
• Standard deviation of sample	s	$s = \sqrt{s^2}$	(4)
• Standard error (also standard error of mean and standard deviation of mean) of sample	$s_{\bar{x}}$	$s_{\bar{x}} = \frac{s}{\sqrt{n}}$	(5)
• Confidence interval for μ[a]	CI	$CI = \bar{x} \pm t_{.20}\, s_{\bar{x}}$, with $t_{.20}$ obtained from Table 2 in this section for appropriate degrees of freedom	(6)
• Regulatory threshold[a]	RT	Defined by EPA (e.g., 100 ppm for barium in elutriate of EP toxicity test)	(7)
• Appropriate number of samples to collect from a solid waste (financial responsibility not considered)	n	$n = \frac{t_{.20}^2 s^2}{\Delta^2}$, with $\Delta = RT - \bar{x}$	(8)

TABLE 1 (Continued)

Terminology	Symbol	Mathematical equation	(Equation)
• Degrees of freedom	df	$df = n - 1$	(9)
• Square root transformation	---	$\sqrt{X_i + 1/2}$	(10)
• Arcsin transformation	---	$\text{Arcsin}\sqrt{p}$; if necessary, refer to any text on basic statistics; measurements must be converted to percentages (p)	(11)

[a]The upper limit of the CI for μ is compared to the applicable regulatory threshold (RT) to determine if a solid waste contains the variable (chemical contaminant) of concern at a hazardous level. The contaminant of concern is not considered to be present in the waste at a hazardous level if the upper limit of the CI is less than the applicable RT. Otherwise, the opposite conclusion is reached.

TABLE 2. TABULATED VALUES OF STUDENT'S "t" FOR EVALUATING SOLID WASTES

Degrees of freedom (n-1)[a]	Tabulated "t" value[b]
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
30	1.310
40	1.303
60	1.296
120	1.289
∞	1.282

[a]Degrees of freedom (df) are equal to the number of samples (n) collected from a solid waste less one.

[b]Tabulated "t" values are for a two-tailed confidence interval and a probability of 0.20 (the same values are applicable to a one-tailed confidence interval and a probability of 0.10).

management of hazardous wastes contain three references regarding the sampling of solid wastes for analytical properties. The first reference, which occurs throughout the regulations, requires that representative samples of waste be collected and defines representative samples as exhibiting average properties of the whole waste. The second reference, which pertains just to petitions to exclude wastes from being listed as hazardous wastes, specifies that enough samples (but in no case less than four samples) be collected over a period of time sufficient to represent the variability of the wastes. The third reference, which applies only to groundwater monitoring systems, mandates that four replicates (subsamples) be taken from each groundwater sample intended for chemical analysis and that the mean concentration and variance for each chemical constituent be calculated from those four subsamples and compared to background levels for groundwater. Even the statistical test to be employed in that comparison is specified (Student's t-test).

The first of the above-described references addresses the issue of sampling accuracy, while the second and third references focus on sampling variability or, conversely, sampling precision (actually the third reference relates to analytical variability, which, in many statistical tests, cannot be distinguished from true sampling variability). Sampling accuracy (the closeness of a sample value to its true value) and sampling precision (the closeness of repeated sample values) are also the issues of overriding importance in any scientific assessment of sampling practices. Thus, from both regulatory and scientific perspectives, the primary objectives of a sampling plan for a solid waste are twofold - namely, to collect samples that will allow sufficiently accurate and precise measurements of the chemical properties of the waste. If the chemical measurements are sufficiently accurate and precise, they will be considered reliable estimates of the chemical properties of the waste.

It is now apparent that a judgment must be made as to the degree of sampling accuracy and precision that is required to reliably estimate the chemical characteristics of a solid waste for the purpose of comparing those characteristics to applicable regulatory thresholds. Generally, high accuracy and high precision are required if one or more chemical contaminants of a solid waste is present at a concentration that is close to the applicable regulatory threshold. Alternatively, relatively low accuracy and low precision can be tolerated if the contaminants of concern occur at levels far below or far above their applicable thresholds. However, a word of caution is in order. Low sampling precision is often associated with considerable savings in analytical, as well as sampling, costs and is clearly recognizable even in the simplest of statistical tests. On the other hand, low sampling accuracy may not entail cost savings and is always obscured (cannot be evaluated) in statistical tests. Therefore, while it is desirable to design sampling plans for solid wastes to achieve only the minimally required precision (at least two samples of a material are required for any estimate of precision), it is prudent to design the plans to attain the greatest possible accuracy.

The roles that inaccurate and imprecise sampling can play in causing a solid waste to be inappropriately judged hazardous are illustrated in Figure 1. When evaluating Figure 1, several points are worthy of consideration. Although a sampling plan for a solid waste generates a mean concentration ($\bar{x}$) and standard deviation (s, a measure of the extent to which individual sample concentrations are dispersed around $\bar{x}$) for each chemical contaminant of concern, it is not the variation of individual sample concentrations that is of ultimate concern, but rather, the variation that characterizes $\bar{x}$ itself. That measure of dispersion is termed the standard deviation of the mean (also, the standard error of the mean or standard error) and is designated as $s_{\bar{x}}$. Those two samples values, $\bar{x}$ and $s_{\bar{x}}$, are used to estimate the interval (range) within which the true mean (μ) of the chemical concentration probably occurs, assuming that the individual concentrations exhibit a normal (bell-shaped) distribution. For the purposes of evaluating solid wastes, the probability level (confidence interval) of 80% has been selected. That is, for each chemical contaminant of concern, a confidence interval (CI) is described within which μ occurs if the sample is representative, which is expected of about 80 out of 100 samples. The upper limit of the 80% CI is then compared to the appropriate regulatory threshold. If the upper limit is less than the threshold, the chemical contaminant is not considered to be present in the waste at a hazardous level; otherwise, the opposite conclusion is drawn. One last point merits explanation. Even if the upper limit of an estimated 80% CI is only slightly less than the regulatory threshold (the worst case of chemical contamination that would be judged acceptable), there is only a 10% (not 20%) chance that the threshold is equaled or exceeded. That is because values of a normally distributed contaminant that are outside the limits of an 80% CI are equally distributed between the left (lower) and right (upper) tails of the normal curve. Consequently, the CI employed to evaluate solid wastes is, for all practical purposes, a 90% interval.

1.1.2 Fundamental Statistical Concepts

The concepts of sampling accuracy and precision have already been introduced along with some measurements of central tendency ($\bar{x}$) and dispersion (standard deviation [s] and $s_{\bar{x}}$) for concentrations of a chemical contaminant of a solid waste. The utility of $\bar{x}$ and $s_{\bar{x}}$ in estimating a confidence interval that probably contains the true mean (μ) concentration of a contaminant has also been described. However, it was noted that the validity of that estimate is predicated upon the assumption that individual concentrations of the contaminant exhibit a normal distribution.

Statistical techniques for obtaining accurate and precise samples are relatively simple and easy to implement. Sampling accuracy is usually achieved by some form of random sampling. In random sampling, every unit in the population (e.g., every location in a lagoon used to store a solid waste) has a theoretically equal chance of being sampled and measured. Consequently,

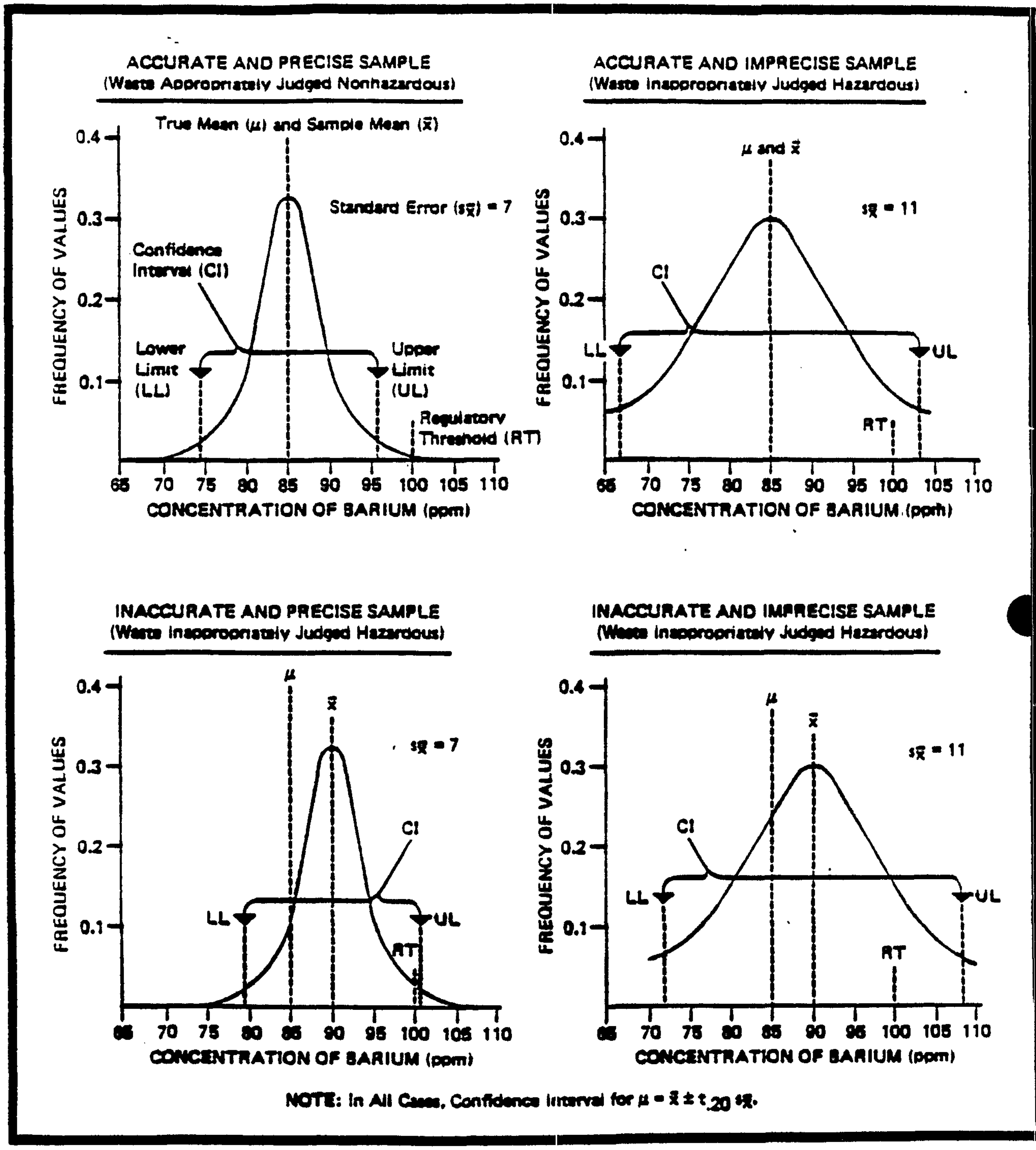

Figure 1.—Important theoretical relationships between sampling accuracy and precision and regulatory objectives for a chemical contaminant of a solid waste that occurs at a concentration marginally less than its regulatory threshold. In this example, barium is the chemical contaminant. The true mean concentration of barium in the elutriate of the EP toxicity test is 85 ppm, as compared to a regulatory threshold of 100 ppm. The upper limit of the confidence interval for the true mean concentration, which is estimated from the sample mean and standard error, must be less than the regulatory threshold if barium is judged to be present in the waste at a nonhazardous level.

statistics generated by the sample (e.g., $\bar{x}$, and, to a lesser degree, $s_{\bar{x}}$) are unbiased (accurate) estimators of true population parameters (e.g., the CI for μ). In other words, the sample is representative of the population. One of the commonest methods of selecting a random sample is to divide the population by an imaginary grid, assign a series of consecutive numbers to the units of the grid, and select the numbers (units) to be sampled through the use of a random numbers table (such a table can be found in any text on basic statistics). It is important to emphasize that a haphazardly selected sample is not a suitable substitute for a randomly selected sample. That is because there is no assurance that a person performing undisciplined sampling will not consciously or subconsciously favor the selection of certain units of the population, thus causing the sample to be unrepresentative of the population.

Sampling precision is most commonly achieved by taking an appropriate number of samples from the population. As can be observed from the equation for calculating $s_{\bar{x}}$, precision increases ($s_{\bar{x}}$ and the CI for μ decrease) as the number of samples (n) increases, although not in a 1:1 ratio. For example, a 100% increase in the number of samples from two to four causes the CI to decrease by approximately 62% (about 31% of that decrease is associated with the critical upper tail of the normal curve). However, another 100% increase in sampling effort from four to eight samples results in only an additional 39% decrease in the CI. Another technique for increasing sampling precision is to maximize the physical size (weight or volume) of the samples that are collected. That has the effect of minimizing between-sample variation and, consequently, decreasing $s_{\bar{x}}$. Increasing the number or size of samples taken from a population, in addition to increasing sampling precision, has the secondary effect of increasing sampling accuracy.

In summary, reliable information concerning the chemical properties of a solid waste is needed for the purpose of comparing those properties to applicable regulatory thresholds. If chemical information is to be considered reliable, it must be accurate and sufficiently precise. Accuracy is usually achieved by incorporating some form of randomness into the selection process for the samples that generate the chemical information. Sufficient precision is most often obtained by selecting an appropriate number of samples.

There are a few ramifications of the above-described concepts that merit elaboration. If, for example, as in the case of semiconductor etching solutions, each batch of a waste is completely homogeneous with regard to the chemical properties of concern and that chemical homogeneity is constant (uniform) over time (from batch to batch), a single sample collected from the waste at an arbitrary location and time would theoretically generate an accurate and precise estimate of the chemical properties. However, most wastes are heterogeneous in terms of their chemical properties. If a batch of waste is randomly heterogeneous with regard to its chemical characteristics and that random chemical heterogeneity remains constant from batch to batch, accuracy and appropriate precision can usually be achieved by simple random sampling. In that type of sampling, all units in the population (essentially all locations or points in all batches of waste from which a sample could be collected) are identified, and a suitable number of samples is randomly selected from the population. More complex stratified random sampling is appropriate if a batch of waste is known to be nonrandomly heterogeneous in terms of its chemical properties and/or nonrandom chemical heterogeneity is known to exist from batch to batch. In such cases, the population is stratified to isolate the known sources of nonrandom chemical heterogeneity. After stratification, which may occur over space (locations or points in a batch of waste) and/or time (each batch of waste), the units in each stratum are numerically identified, and a simple random sample is taken from each stratum. As previously intimated, both simple and stratified random sampling generate accurate estimates of the chemical properties of a solid waste. The advantage of stratified random sampling over simple random sampling is that, for a given number of samples and a given sample size, the former technique often results in a more precise estimate of chemical properties of a waste (a lower value of $s_{\bar{x}}$) than the latter technique. However, greater precision is likely to be realized only if a waste exhibits substantial nonrandom chemical heterogeneity and stratification efficiently "divides" the waste into strata that exhibit maximum between-strata variability and minimum within-strata variability. If that does not occur, stratified random sampling can produce results that are less precise than in the case of simple random sampling. Therefore, it is reasonable to select stratified random sampling over simple random sampling only if the distribution of chemical contaminants in a waste is sufficiently known to allow an intelligent identification of strata and at least two or three samples can be collected in each stratum. If a strategy employing stratified random sampling is selected, a decision must be made regarding the allocation of sampling effort among strata. When chemical variation within each stratum can be estimated with a great degree of detail, samples should be optimally allocated among strata, i.e., the number of samples collected from each stratum should be directly proportional to the chemical variation encountered in the stratum. When detailed information concerning chemical variability within strata is not available, samples should be proportionally allocated among strata, i.e., sampling effort in each stratum should be directly proportional to the size of the stratum.

Simple random sampling and stratified random sampling are types of probability sampling, which, because of a reliance upon mathematical and statistical theories, allows an evaluation of the effectiveness of sampling procedures. Another type of probability sampling is systematic random sampling, in which the first unit to be collected from a population is randomly selected, but all subsequent units are taken at fixed space or time intervals. An example of systematic random sampling is the sampling of a waste lagoon along a transect in which the first sampling point on the transect is 1 m from a randomly selected location on the shore and subsequent sampling points are located at 2-m intervals along the transect. The advantages of systematic random sampling over simple random sampling and stratified random sampling are the ease in which samples are identified and collected (the selection of the first sampling unit determines the remainder of the units) and, sometimes, an increase in precision. In certain cases, for example, systematic random sampling might be expected to be a little more precise than stratified random sampling with one unit per stratum because samples are distributed more evenly over the population. As will be demonstrated shortly, disadvantages of systematic random sampling are the poor accuracy and precision that can occur when unrecognized trends or cycles occur in the population. For those reasons, systematic random sampling is recommended only when a population is essentially random or contains at most a modest stratification. In such cases, systematic random sampling would be employed for the sake of convenience, with little expectation of an increase in precision over other random sampling techniques.

Probability sampling is contrasted with authoritative sampling, in which an individual who is well acquainted with the solid waste to be sampled selects a sample without regard to randomization. The validity of data gathered in that manner is totally dependent on the knowledge of the sampler and, although valid data can sometimes be obtained, authoritative sampling is not recommended for the chemical characterization of most wastes.

It may now be useful to offer a generalization regarding the four sampling strategies that have been identified for solid wastes. If little or no information is available concerning the distribution of chemical contaminants of a waste, simple random sampling is the most appropriate sampling strategy. As more information is accumulated for the contaminants of concern, greater consideration can be given (in order of the additional information required) to stratified random sampling, systematic random sampling, and, perhaps, authoritative sampling.

The validity of a CI for the true mean (μ) concentration of a chemical contaminant of a solid waste is, as previously noted, based on the assumption that individual concentrations of the contaminant exhibit a normal distribution. This is true regardless of the strategy that is employed to sample the waste. Although there are computational procedures for evaluating the correctness of the assumption of normality, those procedures are meaningful only if a large number of samples are collected from a waste. Since sampling plans for most solid wastes entail just a few samples, one can do little more than superficially examine resulting data for obvious departures from normality (this can be done by simple graphical methods), keeping in mind that even if individual measurements of a chemical contaminant of a waste exhibit a considerably abnormal distribution, such abnormality is not likely to be the case for sample means, which are our primary concern. One can also compare the mean of the sample ($\bar{x}$) to the variance of the sample (s^2). In a normally distributed population, $\bar{x}$ would be expected to be greater than s^2 (assuming that the number of samples [n] is reasonably large). If that is not the case, the chemical contaminant of concern may be characterized by a Poisson distribution ($\bar{x}$ is approximately equal to s^2) or a negative binomial distribution ($\bar{x}$ is less than s^2). In the former circumstance, normality can often be achieved by transforming data according to the square root transformation. In the latter circumstance, normality may be realized through use of the arcsine transformation.

If either transformation is required, all subsequent statistical evaluations must be performed on the transformed scale.

Finally, it is necessary to address the appropriate number of samples to be employed in the chemical characterization of a solid waste. As has already been emphasized, the appropriate number of samples is the least number of samples required to generate a sufficiently precise estimate of the true mean (μ) concentration of a chemical contaminant of a waste. From the perspective of most waste producers, that means the minimal number of samples needed to demonstrate that the upper limit of the CI for μ is less than the applicable regulatory threshold (RT). The formula for estimating appropriate sampling effort (Table 1, Equation 8) indicates that increased sampling effort is generally justified as s^2 or the "$t_{.20}$" value (probable error rate) increases and as Δ (RT - $\bar{x}$) decreases. In a well-designed sampling plan for a solid waste, an effort is made to estimate the values of $\bar{x}$ and s^2 before sampling is initiated. Such preliminary estimates, which may be derived from information pertaining to similar wastes, process engineering data, or limited analytical studies, are used to identify the approximate number of samples that must be collected from the waste. It is always prudent to collect a somewhat greater number of samples than indicated by preliminary estimates of x and s^2 since poor preliminary estimates of those statistics can result in an underestimate of the appropriate number of samples to collect. It is usually possible to appropriately process and store the extra samples until analysis of the initially identified samples is completed and it can be determined if analysis of the additional samples is warranted.

1.1.3 Basic Sampling Strategies

It is now appropriate to present general procedures for implementing the three previously introduced sampling strategies (simple random sampling, stratified random sampling, and systematic random sampling) and a hypothetical example of each sampling strategy. The hypothetical examples illustrate the statistical calculations that must be performed in most situations likely to be encountered by a waste producer and, also, provide some insight into the efficiency of the three sampling strategies in meeting regulatory objectives.

The following hypothetical conditions are assumed to exist for all three sampling strategies. First, barium, which has a RT of 100 ppm as measured in the EP elutriate test, is the only chemical contaminant of concern. Second, barium is discharged in particulate form to a waste lagoon and accumulates in the lagoon in the form of a sludge, which has built up to approximately the same thickness throughout the lagoon. Third, concentrations of barium are relatively homogeneous along the vertical gradient (from the water-sludge interface to the sludge-lagoon interface), suggesting a highly controlled manufacturing process (little between-batch variation in barium concentrations).

Fourth, the physical size of sludge samples collected from the lagoon is as large as practical, and barium concentrations derived from those samples are normally distributed (note that we do not refer to barium levels in the samples of sludge since barium measurements are actually made on the elutriate from EP toxicity tests performed with the samples). Last, a preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago identified values of 86 and 90 ppm for material collected near the outfall (in the upper third) of the lagoon and values of 98 and 104 ppm for material obtained from the far end (the lower two-thirds) of the lagoon.

For all sampling strategies, it is important to remember that barium will be determined to be present in the sludge at a hazardous level if the upper limit of the CI for μ is equal to or greater than the RT of 100 ppm (Table 1, Equations 6 and 7).

1.1.3.1 Simple Random Sampling

Simple random sampling (Box 1) is performed by general procedures in which preliminary estimates of $\bar{x}$ and s^2, as well as a knowledge of the RT, for each chemical contaminant of a solid waste that is of concern are employed to estimate the appropriate number of samples (n) to be collected from the waste. That number of samples is subsequently analyzed for each chemical contaminant of concern. The resulting analytical data are then used to definitively conclude that each contaminant is or is not present in the waste at a hazardous concentration or, alternatively, to suggest a reiterative process, involving increased sampling effort, through which the presence or absence of hazard can be definitively determined.

In the hypothetical example for simple random sampling (Box 1), preliminary estimates of $\bar{x}$ and s^2 indicated a sampling effort consisting of six samples. That number of samples was collected and initially analyzed, generating analytical data somewhat different from the preliminary data (s^2 was substantially greater than was preliminarily estimated). Consequently, the upper limit of the CI was unexpectedly greater than the applicable RT, resulting in a tentative conclusion of hazard. However, a reestimation of appropriate sampling effort, based on statistics derived from the six samples, suggested that such a conclusion might be reversed through the collection and analysis of just one more sample. Fortunately, a resampling effort was not required because of the foresight of the waste producer in obtaining three extra samples during the initial sampling effort, which, because of their influence in decreasing the final values of $\bar{x}$, $s_{\bar{x}}$, $t_{.20}$, and, consequently, the upper limit of the CI - values obtained from all nine samples - resulted in a definitive conclusion of nonhazard.

BOX 1. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - SIMPLE RANDOM SAMPLING OF WASTES

Step	General Procedures
1.	Obtain preliminary estimates of $\bar{x}$ and s^2 for each chemical contaminant of a solid waste that is of concern. The two above-identified statistics are calculated by, respectively, Equations 2a and 3a (Table 1).
2.	Estimate the appropriate number of samples (n_1) to be collected from the waste through use of Equation 8 (Table 1) and Table 2. Derive individual values of n_1 for each chemical contaminant of concern. The appropriate number of samples to be taken from the waste is the greatest of the individual n_1 values.
3.	Randomly collect at least n_1 samples (or $n_2 - n_1$, $n_3 - n_2$, etc. samples, as will be indicated later in this box) from the waste (collection of a few extra samples will provide protection against poor preliminary estimates of $\bar{x}$ and s^2). Maximize the physical size (weight or volume) of all samples that are collected.
4.	Analyze the n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc.) samples for each chemical contaminant of concern. Superficially (graphically) examine each set of analytical data for obvious departures from normality.
5.	Calculate $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ for each set of analytical data by, respectively, Equations 2a, 3a, 4, and 5 (Table 1).
6.	If $\bar{x}$ for a chemical contaminant is equal to or greater than the applicable RT (Equation 7; Table 1)) and is believed to be an accurate estimator of μ, the contaminant is considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with nontransformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data. Square root and arcsine transformations are defined by, respectively, Equations 10 and 11 (Table 1).
7.	Determine the CI for each chemical contaminant of concern by Equation 6 (Table 1) and Table 2. If the upper limit of the CI is less than the applicable RT (Equations 6 and 7; Table 1), the chemical contaminant is not considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

8. If a tentative conclusion of hazard is reached, reestimate the total number of samples (n_2) to be collected from the waste by use of Equation 8 (Table 1) and Table 2. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If an additional $n_2 - n_1$ samples of waste cannot reasonably be collected, the study is completed and a definitive conclusion of hazard is reached. Otherwise, collect an extra $n_2 - n_1$ samples of waste.

9. Repeat the basic operations described in Steps 3-8 until the waste is judged to be nonhazardous or, if the opposite conclusion continues to be reached, increased sampling effort is impractical.

Hypothetical Example

Step

1. The preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago generated values of 86 and 90 ppm for sludge obtained from the upper third of the lagoon and values of 98 and 104 ppm for sludge from the lower two-thirds of the lagoon. Those two sets of values are not judged to be indicative of nonrandom chemical heterogeneity (stratification) within the lagoon. Therefore, preliminary estimates of $\bar{x}$ and s^2 are calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{86 + 90 + 98 + 104}{4} = 94.50\text{, and} \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{35{,}916.00 - 35{,}721.00}{3} = 65.00.$$

2. Based on the preliminary estimates of $\bar{x}$ and s^2, as well as the knowledge that the RT for barium is 100 ppm,

$$n_1 = \frac{t_{.20}^2 s^2}{\Delta^2} = \frac{(1.638^2)(65.00)}{5.50^2} = 5.77. \qquad \text{(Equation 8)}$$

3. As indicated above, the appropriate number of sludge samples (n_1) to be collected from the lagoon is six. That number of samples (plus three extra samples for protection against poor preliminary estimates of $\bar{x}$ and s^2) is collected from the lagoon by a single randomization process (Figure 2). All samples consist of the greatest volume of sludge that can be practically collected. The three extra samples are suitably processed and stored for possible later analysis.

4. The six samples of sludge (n_1) designated for immediate analysis generate the following concentrations of barium in the EP toxicity test: 89, 90, 87, 96, 93, and 113 ppm. Although the value of 113 ppm appears unusual as compared to the other data, there is no obvious indication that the data are not normally distributed.

5. New values for $\bar{x}$ and s^2 and associated values for the standard deviation (s) and $s_{\bar{x}}$ are calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{89 + 90 + 87 + 96 + 93 + 113}{6} = 94.67, \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{54{,}224.00 - 53{,}770.67}{5} = 90.67,$$

$$s = \sqrt{s^2} = 9.52, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 9.52/\sqrt{6} = 3.89. \qquad \text{(Equation 5)}$$

6. The new value for $\bar{x}$ (94.67) is less than the RT (100). In addition, $\bar{x}$ is greater (only slightly) than s^2 (90.67) and, as previously indicated, the raw data are not characterized by obvious abnormality. Consequently, the study is continued, with the following calculations performed with nontransformed data.

7. $$CI = \bar{x} \pm t_{.20}\, s_{\bar{x}} = 94.67 \pm (1.476)(3.89) \qquad \text{(Equation 6)}$$

$$= 94.67 \pm 5.74.$$

Since the upper limit of the CI (100.41) is greater than the applicable RT (100), it is tentatively concluded that barium is present in the sludge at a hazardous concentration.

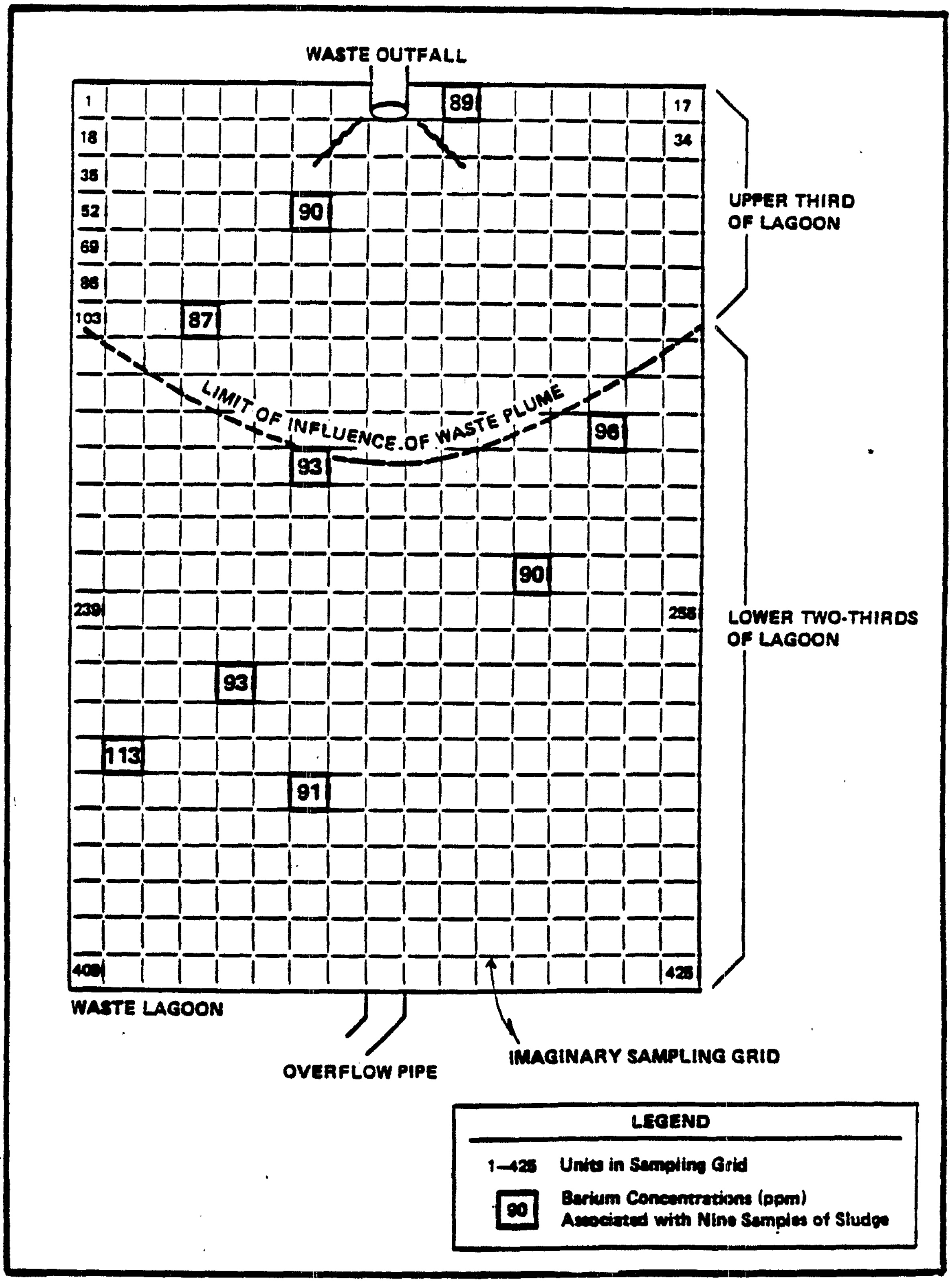

Figure 2.—Hypothetical sampling conditions in waste lagoon containing sludge contaminated with barium. Barium concentrations associated with samples of sludge refer to levels measured in the elutriate of EP toxicity tests conducted with the samples.

8. n is now reestimated as:

$$n_2 = \frac{t^2_{.20}s^2}{\Delta^2} \quad \frac{(1.476^2)(90.67)}{5.33^2} = 6.95. \qquad \text{(Equation 8)}$$

The value for n_2 ($\sim$7) indicates that an additional ($n_2 - n_1 = 1$) sludge sample should be collected from the lagoon.

9. The additional sampling effort is not necessary because of the three extra samples that were initially collected from the lagoon. All extra samples are analyzed, generating the following levels of barium for the EP toxicity test: 93, 90, and 91 ppm. Consequently, $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ are recalculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i}{n} = \frac{89 + 90 + \ldots + 91}{9} = 93.56, \qquad \text{(Equation 2a)}$$

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2/n}{n - 1} \qquad \text{(Equation 3a)}$$

$$= \frac{79{,}254.00 - 78{,}773.78}{8} = 60.03,$$

$$s = \sqrt{s^2} = 7.75, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 7.75/\sqrt{9} = 2.58. \qquad \text{(Equation 5)}$$

The value for $\bar{x}$ (93.56) is again less than the RT (100), and there is no indication that the nine data points, considered collectively, are abnormally distributed (in particular, $\bar{x}$ is now substantially greater than s^2). Consequently, CI, calculated with nontransformed data, is determined to be:

$$CI = \bar{x} \pm t_{.20}s_{\bar{x}} = 93.56 \pm (1.397)(2.58) \qquad \text{(Equation 6)}$$

$$= 93.56 \pm 3.60.$$

The upper limit of the CI (97.16) is now less than the RT of 100. Consequently, it is definitively concluded that barium is not present in the sludge at a hazardous level.

1.1.3.2 Stratified Random Sampling

Stratified random sampling (Box 2) is conducted by general procedures that are similar to the procedures described for simple random sampling. The only difference is that, in stratified random sampling, values of $\bar{x}$ and s^2 are calculated for each stratum in the population and then integrated into overall estimates of those statistics, the standard deviation (s), $s_{\bar{x}}$, and the appropriate number of samples (n) for all strata.

The hypothetical example for stratified random sampling (Box 2) is based on the same nine sludge samples previously identified in the example of simple random sampling (Box 1) so that the relative efficiencies of the two sampling strategies can be fully compared. The efficiency generated through the process of stratification is first evident in the preliminary estimate of n (Step 2 in Boxes 1 and 2), which is six for simple random sampling and four for stratified random sampling. (The lesser value for stratified sampling is the consequence of a dramatic decrease in s^2, which more than compensated for a modest increase in Δ.) The most relevant indication of sampling efficiency is the value of $s_{\bar{x}}$, which is directly employed to calculate the CI. In the case of simple random sampling, $s_{\bar{x}}$ is calculated as 2.58 (Step 9 in Box 1), while, for stratified random sampling, $s_{\bar{x}}$ is determined to be 2.35 (Steps and 5 and 7 in Box 2). Consequently, the gain in efficiency attributable to stratification is approximately 9% (0.23/2.58).

1.1.3.3 Systematic Random Sampling

Systematic random sampling (Box 3) is implemented by general procedures that are identical to the procedures identified for simple random sampling. The hypothetical example for systematic random sampling (Box 3) demonstrates the bias and imprecision that are associated with that type of sampling when unrecognized trends or cycles exist in the population.

1.1.4 Special Considerations

The preceding discussion has addressed the major issues that are critical to the development of a reliable sampling strategy for a solid waste. The remaining discussion focuses on several "secondary" issues that should be considered when designing an appropriate sampling strategy. These secondary issues are applicable to all three of the basic sampling strategies that have been identified.

BOX 2. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - STRATIFIED RANDOM SAMPLING OF WASTES

Step	General Procedures
1.	Obtain preliminary estimates of $\bar{x}$ and s^2 for each chemical contaminant of a solid waste that is of concern. The two above-identified statistics are calculated by, respectively, Equations 2b and 3b (Table 1).
2.	Estimate the appropriate number of samples (n_1) to be collected from the waste through use of Equation 8 (Table 1) and Table 2. Derive individual values of n_1 for each chemical contaminant of concern. The appropriate number of samples to be taken from the waste is the greatest of the individual n_1 values.
3.	Randomly collect at least n_1 samples (or $n_2 - n_1$, $n_3 - n_2$, etc. samples, as will be indicated later in this box) from the waste (collection of a few extra samples will provide protection against poor preliminary estimates of $\bar{x}$ and s^2). If s_k for each stratum (see Equation 3b) is believed to be an accurate estimate, optimally allocate samples among strata (i.e., allocate samples among strata so that the number of samples collected from each stratum is directly proportional to s_k for that stratum). Otherwise, proportionally allocate samples among strata according to size of the strata. Maximize the physical size (weight or volume) of all samples that are collected from the strata.
4.	Analyze the n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc.) samples for each chemical contaminant of concern. Superficially (graphically) examine each set of analytical data from each stratum for obvious departures from normality.
5.	Calculate $\bar{x}$, s^2, the standard deviation (s), and $s_{\bar{x}}$ for each set of analytical data by, respectively, Equations 2b, 3b, 4, and 5 (Table 1).
6.	If $\bar{x}$ for a chemical contaminant is equal to or greater than the applicable RT (Equation 7; Table 1) and is believed to be an accurate estimator of μ, the contaminant is considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with nontransformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data. Square root and arcsine transformations are defined by, respectively, Equations 10 and 11 (Table 1).

7. Determine the CI for each chemical contaminant of concern by Equation 6 (Table 1) and Table 2. If the upper limit of the CI is less than the applicable RT (Equations 6 and 7; Table 1), the chemical contaminant is not considered to be present in the waste at a hazardous concentration and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

8. If a tentative conclusion of hazard is reached, reestimate the total number of samples (n_2) to be collected from the waste by use of Equation 8 (Table 1) and Table 2. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If an additional $n_2 - n_1$ samples of waste cannot reasonably be collected, the study is completed and a definitive conclusion of hazard is reached. Otherwise, collect an extra $n_2 - n_1$ samples of waste.

9. Repeat the basic operations described in Steps 3-8 until the waste is judged to be nonhazardous or, if the opposite conclusion continues to be reached, increased sampling effort is impractical.

Hypothetical Example

Step

1. The preliminary study of barium levels in the elutriate of four EP toxicity tests conducted with sludge collected from the lagoon several years ago generated values of 86 and 90 ppm for sludge obtained from the upper third of the lagoon and values of 98 and 104 ppm for sludge from the lower two-thirds of the lagoon. Those two sets of values are judged to be indicative of nonrandom chemical heterogeneity (two strata) within the lagoon. Therefore, preliminary estimates of $\bar{x}$ and s^2 are calculated as:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k = \frac{(1)(88.00)}{3} + \frac{(2)(101.00)}{3} = 96.67, \text{ and} \qquad \text{(Equation 2b)}$$

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 = \frac{(1)(8.00)}{3} + \frac{(2)(18.00)}{3} = 14.67. \qquad \text{(Equation 3b)}$$

2. Based on the preliminary estimates of $\bar{x}$ and s^2, as well as the knowledge that the RT for barium is 100 ppm,

$$n_1 = \frac{t_{.20}^2 s^2}{\Delta^2} = \frac{(1.368^2)(14.67)}{3.33^2} = 3.55. \qquad \text{(Equation 8)}$$

3. As indicated above, the appropriate number of sludge samples (n_1) to be collected from the lagoon is four. However, for purposes of comparison to simple random sampling (Box 1), six samples (plus three extra samples for protection against poor preliminary estimates of $\bar{x}$ and s^2) are collected from the lagoon by a two-stage randomization process (Figure 2). Because s_k for the upper (2.12 ppm) and lower (5.66 ppm) strata are not believed to be very accurate estimates, the nine samples to be collected from the lagoon are not optimally allocated between the two strata (optimum allocation would require two and seven samples to be collected from the upper and lower strata, respectively). Alternatively, proportional allocation is employed - three samples are collected from the upper stratum (which represents one-third of the lagoon), and six samples are taken from the lower stratum (two-thirds of the lagoon). All samples consist of the greatest volume of sludge that can be practically collected.

4. The nine samples of sludge generate the following concentrations of barium in the EP toxicity test: upper stratum - 89, 90, and 87 ppm; lower stratum - 96, 93, 113, 93, 90, and 91 ppm. Although the value of 113 ppm appears unusual as compared to other data for the lower stratum, there is no obvious indication that the data are not normally distributed.

5. New values for $\bar{x}$ and s^2 and associated values for the standard deviation (s) and $s_{\bar{x}}$ are calculated as:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k = \frac{(1)(88.67)}{3} + \frac{(2)(96.00)}{3} = 93.56, \qquad \text{(Equation 2b)}$$

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 = \frac{(1)(2.33)}{3} + \frac{(2)(73.60)}{3} = 49.84, \qquad \text{(Equation 3b)}$$

$$s = \sqrt{s^2} = 7.06, \text{ and} \qquad \text{(Equation 4)}$$

$$s_{\bar{x}} = s/\sqrt{n} = 7.06/\sqrt{9} = 2.35. \qquad \text{(Equation 5)}$$

6. The new value for $\bar{x}$ (93.56) is less than the RT (100). In addition, $\bar{x}$ is greater than s^2 (49.84) and, as previously indicated, the raw data are not characterized by obvious abnormality. Consequently, the study is continued, with the following calculation performed with nontransformed data.

7. $$CI = \bar{x} \pm t_{.20} s_{\bar{x}} = 93.56 \pm (1.397)(2.35) \qquad \text{(Equation 6)}$$

$$= 93.56 \pm 3.28.$$

The upper limit of the CI (96.84) is less than the applicable RT (100). Therefore, it is concluded that barium is not present in the sludge at a hazardous concentration.

BOX 3. STRATEGY FOR DETERMINING IF CHEMICAL CONTAMINANTS OF SOLID WASTES ARE PRESENT AT HAZARDOUS LEVELS - SYSTEMATIC RANDOM SAMPLING

Step	General Procedure
1.	Follow general procedures presented for simple random sampling of solid wastes (Box 1).
Step	**Hypothetical Example**
1.	The example presented in Box 1 is applicable to systematic random sampling with the understanding that the nine sludge samples obtained from the lagoon would be collected at equal intervals along a transect running from a randomly selected location on one bank of the lagoon to the opposite bank. If that randomly selected transect were established between Units 1 and 409 of the sampling grid (Figure 2) and sampling were performed at Unit 1 and, thereafter, at three-unit intervals along the transect (i.e., Unit 1, Unit 52, Unit 103, . . . , and Unit 409), it is apparent that only two samples would be collected in the upper third of the lagoon, while seven samples would be obtained from the lower two-thirds of the lagoon. If, as suggested by the barium concentrations illustrated in Figure 2, the lower part of the lagoon is characterized by greater and more variable barium contamination than the upper part of the lagoon, systematic random sampling along the above-identified transect, by placing undue (disproportionate) emphasis on the lower part of the lagoon, might be expected to result in an inaccurate (overestimation) and imprecise characterization of barium levels in the whole lagoon, as compared to either simple random sampling or stratified random sampling. Such inaccuracy and imprecision, which is typical of systematic random sampling when unrecognized trends or cycles occur in the population, would be magnified if, for example, the randomly selected transect were established solely in the lower part of the lagoon, e.g., between Units 239 and 255 of the sampling grid.

1.1.4.1 Composite Sampling

In composite sampling, a number of random samples are initially collected from a waste and combined into a single sample, which is then analyzed for the chemical contaminants of concern. The major disadvantage of composite sampling as compared to noncomposite sampling is that information concerning the chemical contaminants is lost, i.e., each initial set of samples generates only a single estimate of the concentration of each contaminant. Consequently, since the number of analytical measurements (n) is small, $s_{\bar{x}}$ and $t_{.20}$ are large, thus decreasing the likelihood that a contaminant will be judged to occur in the waste at a nonhazardous level (refer to appropriate equations Table 1 and to Table 2). A remedy to that situation is to collect and analyze a relatively large number of composite samples, thereby offsetting the savings in analytical costs that are often associated with composite sampling, but achieving better representation of the waste than would occur with noncomposite sampling.

The appropriate number of composite samples to be collected from a solid waste is estimated by use of Equation 8 (Table 1) as previously described for the three basic sampling strategies. In comparison to noncomposite sampling, composite sampling may have the effect of minimizing between-sample variation (the same phenomenon that occurs when the physical size of a sample is maximized), thereby reducing somewhat the number of samples that must be collected from the waste.

1.1.4.2 Subsampling

The variance (s^2) associated with a chemical contaminant of a waste consists of two components in that:

$$s^2 = s_s^2 + \frac{s_a^2}{m}, \qquad \text{(Equation 12)}$$

with s_s^2 = a component attributable to sampling (sample) variation, s_a^2 = a component attributable to analytical (subsample) variation, and m = number of subsamples. In general, s_a^2 should not be allowed to exceed one-ninth of s_s^2. If a preliminary study indicates that s_a^2 exceeds that threshold, a sampling strategy involving subsampling should be considered. In such a strategy, a number of replicate measurements are randomly made on a relatively limited number of randomly collected samples. Consequently, analytical effort is allocated as a function of analytical variability. The efficiency of that general strategy in meeting regulatory objectives has already been demonstrated in the previous discussions of sampling effort.

The appropriate number of samples (n) to be collected from a solid waste for which subsampling will be employed is again estimated by Equation 8 (Table 1). In the case of simple random sampling or systematic random sampling with an equal number of subsamples analyzed per sample:

$$\bar{x} = \sum_{i=1}^{n} \bar{x}_i/n, \qquad \text{(Equation 13)}$$

with $\bar{x}_i$ = sample mean (calculated from values for subsamples) and n = number of samples. Also,

$$s^2 = \frac{\sum_{i=1}^{n} \bar{x}_i^2 - (\sum_{i=1}^{n} \bar{x}_i)^2/n}{n - 1}. \qquad \text{(Equation 14)}$$

The optimum number of subsamples to be taken from each sample ($m_{opt.}$) is estimated as:

$$m(opt.) = \frac{s_a}{s_s} \qquad \text{(Equation 15)}$$

when cost factors are not considered. The value for s_a is calculated from available data as:

$$s_a = \sqrt{\frac{\sum_{i=1}^{n} \sum_{j=1}^{m} X_{ij}^2 - (\sum X_{ij})^2/m}{n\,(m - 1)}}, \qquad \text{(Equation 16)}$$

and s_s, which can have a negative characteristic, is defined as:

$$s_s = \sqrt{s^2 - \frac{s_a^2}{m}}, \qquad \text{(Equation 17)}$$

with s^2 calculated as indicated in Equation 14.

In the case of stratified random sampling with subsampling, critical formulas for estimating sample size (n) by Equation 8 (Table 1) are:

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k, \qquad \text{(Equation 2b)}$$

with $\bar{x}_k$ = stratum mean and W_k = fraction of population represented by Stratum K (number of strata, k, ranges from 1 to r). In Equation 2b, $\bar{x}_k$ for each stratum is calculated as the average of all sample means in the stratum (sample means are calculated from values for subsamples). In addition:

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 , \qquad \text{(Equation 3b)}$$

with s_k^2 for each stratum calculated from all sample means in the stratum. The optimum subsampling effort when cost factors are not considered and all replication is symmetrical is again estimated as:

$$m(\text{opt.}) = \frac{s_a}{s_s} \text{ , with} \qquad \text{(Equation 15)}$$

$$s_a = \sqrt{\frac{\sum_{k=1}^{r}\sum_{i=1}^{n}\sum_{j=1}^{m} X_{kij}^2 - (\Sigma X_{kij})^2/m}{rn\,(m-1)}} \text{ , and} \qquad \text{(Equation 18)}$$

$$s_s = \sqrt{s^2 - \frac{s_a^2}{m}} , \qquad \text{(Equation 17)}$$

with s^2 derived as shown in Equation 3b.

1.1.4.3 Cost and Loss Functions

The cost of chemically characterizing a waste is dependent on the specific strategy that is employed to sample the waste. For example, in the case of simple random sampling without subsampling, a reasonable cost function might be:

$$C_{(n)} = C_o + C_1 n , \qquad \text{(Equation 19)}$$

with $C_{(n)}$ = cost of employing a sample size of n, C_o = an overhead cost (which is independent of the number of samples that are collected and analyzed), and C_1 = a sample-dependent cost. A consideration of $C_{(n)}$ mandates an evaluation of $L_{(n)}$, which is the sample-size-dependent expected financial loss related to the erroneous conclusion that a waste is hazardous. A simple loss function is:

$$L_{(n)} = \frac{\alpha s^2}{n}, \qquad \text{(Equation 20)}$$

with α = a constant related to the cost of a waste management program if the waste is judged to be hazardous, s^2 = sample variance, and n = number of samples. A primary objective of any sampling strategy is to minimize $C_{(n)} + L_{(n)}$. Differentiation of Equations 19 and 20 indicates that the number of samples (n) which minimize $C_{(n)} + L_{(n)}$ is:

$$n = \sqrt{\frac{\alpha s^2}{C_1}}. \qquad \text{(Equation 21)}$$

As is evident from Equation 21, a comparatively large number of samples (n) is justified if the value of α or s^2 is large, whereas a relatively small number of samples is appropriate if the value of C_1 is large. These general conclusions are valid for any sampling strategy for a solid waste.

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7445-03-014

April 5, 1990

OH Materials
4 Research Way
Princeton, NJ 08540
c/o Chris Zwiebel

Re: Tonolli Water Results

Sampled By : C.Z.

RESULTS

Parameter	System Influent	System Effluent	Methodology
Lead - Total (mg/l)	3.08	0.016	EPA No. 239.1
Lead - Dissolved (mg/l)	1.61	0.012	EPA No. 239.1
Copper - Total (mg/l)	0.041	0.010	EPA No. 220.2
Copper - Dissolved (mg/l)	0.028	<0.001	EPA No. 220.2
Iron - Dissolved (mg/l)	0.027	<0.005	EPA No. 236.1
Antimony (mg/l)	0.161	0.081	EPA No. 204.2
Beryllium (mg/l)	0.010	<0.005	EPA No. 210.2
Cadmium (mg/l)	0.036	0.017	EPA No. 213.2
Silver (mg/l)	0.0015	<0.0005	EPA No. 272.2
Tin (mg/l)	0.013	0.005	EPA No. 282.2
Zinc (mg/l)	0.27	0.073	EPA No. 289.1

Date Sampled	4/2/90	4/2/90
Time Sampled	1055	1100
Sample No.	8839	8840

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