



RADIOCHEMICAL ANALYSIS

ADDENDUM NO. 2 : SOIL / WASTE SAMPLING

PFOHL BROTHERS LANDFILL

Cheektowaga, New York, Erie County

Site No. 09-15-043

MARCH 1990

Reported By:

New York State Department of Health
Bureau of Environmental Exposure Investigation
Bureau of Environmental Radiation Protection
New York State Department of Environmental Conservation
Division of Hazardous Waste Remediation /
Hazardous Substance Regulation

1.0 INTRODUCTION

This report contains information gathered at the Pfohl Brothers Landfill site pertaining to soils and discrete objects which were located in elevated radiation areas. The elevated radiation areas were those areas which had radiation readings greater than three times the typical background level of radiation established for the vicinity of this site. A more thorough description of the "hot spot" areas of the site can be found in the "Walk-over Gamma Radiation Survey" dated October, 1989.

1.1 Objectives of the Soil/Waste Sampling Program

1. Determine the source of radiation "hot spot" readings identified at the Pfohl Brothers Landfill.
2. Determine if the radiation is a threat to human health or the environment.

2.0 SAMPLING METHODOLOGY

2.1 Preliminary Investigation

Table 2-1 contains the results of soil samples taken during June, 1988. Sample BKG1 was a background sample taken off-site on the west side of Scott Place and approximately 1/4 mile west of the site boundary. The background level of radiation was confirmed using a micro rad meter prior to sampling. Sample BKG2 was an additional background sample taken off site at a location north of Aero Drive at the Rein Road intersection. Sample B-1 was taken in the northwest area of Area B of the site where radiation levels were approximately three times background. Sample B-2 was taken more toward the center of Area B where the readings were found to be 1.5 to 2 times background. The soil samples were taken with a hand trowel at approximately 2-3 inches of depth and were sent to the Laboratory of Inorganic and Nuclear Chemistry of the Wadsworth Center for Laboratory and Research. The results were reported by the New York State Department of Health (NYSDOH), Bureau of Environmental Radiation Protection.

2.2 Phase I Survey Sampling

Subsequent to this preliminary investigation, a work plan was developed to further survey the site to identify areas greater than three times background radiation. As the site was being surveyed in September 1988, further elevated radiation areas were found and the New York State Department of Environmental Conservation (NYSDEC), Bureau of Radiation, collected seven additional soil samples. These samples were analyzed by Clean Harbors Analytical Services, Inc. and reported by the Bureau of Radiation. The results of the analysis are contained in Table 2-2. The following chart describes the seven soil samples taken in September 1988:

SEPTEMBER 1988 SAMPLES

<u>Soil Sample No.</u>	<u>Sample Location</u>	<u>Sample Description</u>
013	Northwest 50 ft. from the intersection of Aero Drive & Scott Place	Soil background sample

015	Site Grid Traverse 24+50, 450 ft. south of Aero Drive	Soil; Surface Reading 3 x Background
016	Site Grid Traverse 23+50, 1225 ft. north of Aero Drive	Exposed Drum Surface Reading 20-30 x Background
017	Site Grid Traverse 21+50, 1400 ft. north of Aero Drive	Bag of unknown material reading 10 x Background
018	Site Grid Traverse 16+50, 1325 ft. north of Aero Drive	Soil; Surface reading of 40-80 x Background
019	Site Grid Traverse 29+50, 725 ft. north of Aero Drive	Soil; Surface reading of 10 x Background
020	Site Grid Traverse 38+00, 700 ft. north of Aero Drive	Soil; Surface reading of 10-20 x Background

Based on the results of the radiation findings at the site during 1988 it was determined that further investigative work was necessary to better characterize the levels and types of radiation at the site before intrusive hazardous waste investigations such as the drum investigation, test pits, soil borings etc. could commence. This decision was based primarily on worker health and safety considerations.

A more intensive surface radiation walk-over survey was performed in August, 1989 and in conjunction with this survey, three discrete objects were collected by

the NYSDEC Bureau of Radiation. These samples consisted of two small metallic discs which appeared to be self-luminous glass on metal and a small metal alloy disc. The samples were analyzed by Clean Harbors Laboratory and the results reported by the NYSDEC Bureau of Radiation. The results are contained in Table 2-3. All three objects were found in Area B of the site and are described as follows:

<u>NYSDEC Sample No.</u>	<u>Description</u>
060189001	Piece of scrap metal containing Uranium and Thorium
060189002	Small (approximately 1/2") disc containing Radium paint.
060189003	Small (approximately 1") disc containing Radium paint.

2.2 Phase II Intrusive Survey Sampling

At the conclusion of the surface survey of the site the "Phase I Walk-Over Gamma Radiation Survey, September 1989" was released. Approximately 500 locations were identified in this report with radiation readings greater than twice background readings.

Based upon the findings of the Phase I Survey, in September, 1989 the NYSDEC's consultant, Camp Dresser & McKee (CDM), performed an intrusive investigation at 120 of the highest locations of elevated radiation identified on the site. The "Phase II Radiation Investigation" report to be prepared by CDM will summarize the findings of this investigation. At the conclusion of this investigation the NYSDEC, NYSDOH and Camp Dresser & McKee met to review the samples collected and to decided which samples would be analyzed. The criteria for selection were as as follows:

1. Readings greater than 10 x background; and/or
2. Loose granular material; and/or
3. Large quantity of material.

Using these criteria, the samples identified in Table 2-4 were selected and the NYSDEC delivered 18 samples to Clean Harbors for analysis. Four of these 18 samples were split with an independent analysis performed by the NYSDOH. The split samples

are labeled in Table 2-4 with an "S". For example, the sample R-06 was a split sample. The results from Clean Harbors is R-06 and the separate analysis performed by NYSDOH is R-06S. The analytical results of these samples are reported on Tables 2-5 through 2-7. Two of the 18 samples were discrete objects. These objects were analyzed by Clean Harbors and the results are shown on Table 2-3 (i.e. samples 121289003 and 15).

The NYSDOH also analyzed 4 radium discs, a bag of green powder and the soil around one of the buried radium discs. The analytical results for the radium discs are contained in Table 2-3 (sample numbers 892095338, 341,342,343). The analytical results of the green powder (8920895339) and the soil surrounding disc 8920895341 (i.e. sample 8920895340) are reported in Table 2-8.

A summary of all of the samples collected and analyzed by the NYSDEC and NYSDOH since 1988 is as follows:

Sample Summary

Table 2-1 DOH Sampling	2 Background soil samples - 1988 2 "elevated areas" soil samples - 1988
Table 2-2 DEC Radiation Bureau Sampling	1 Background soil sample - 1988 7 "elevated area" soil samples - 1988
Table 2-3	9 discrete objects found at the site - 1988 & 1989
CDM Sampling Tables: 2-5 Other Radionuclides 2-6 Thorium Series 2-7 Uranium Series	16 soil samples from 1989 intrusive survey - 1989 4 split samples analyzed by NYSDOH - 1989
Table 2-8 Miscellaneous Samples	1 sample of green powder - 1989 1 sample of soil surrounding disc - 1989

3.0 SAMPLING RESULTS AND DISCUSSION

3.1 Soils

The soil samples collected in 1988 by the NYSDOH and reported in Table 2-1 (i.e., BKG1, BKG2, B-2 and B-1) were the initial samples taken at the site. The results indicated that the radionuclides ranged as high as 5 times the background concentrations (BKG1 and BKG2) and that further investigations at the site for radiation were necessary before workers at the site should proceed with other intrusive investigations.

The second set of soil samples, collected by the NYSDEC Bureau of Radiation in 1988 (reported in Table 2-2), indicated that Samples 016 and 017 contain levels of Ra-226 devoid of its naturally occurring uranium-238 series parent nuclides, and Ra-228, thorium-228, and thorium-232 from the naturally occurring thorium-232 series, all above natural background levels. The remaining samples were within normal ranges for radioactivity in soils.

The gross beta measurements for the 1988 samples are not very useful for soil samples unless a large amount of contamination exists at the landfill surface, which does not appear to be the case here. The cesium measured was within the normal range, however, the radium - 226 and thorium - 232 results show some samples with elevated levels. It is possible that there are two distinct radioactive waste streams present, as indicated by the presence of the thorium series and the non-series radium-226.

The sixteen soil/waste samples analyzed at the conclusion of the Phase II Intrusive Radiation Investigation in 1989 are identified on Tables 2-5, 6, 7 and the two discrete objects (samples 121289003 and 15) are included on Table 2-3. The intrusive sampling was conducted in an attempt to identify the sources of elevated readings taken at the surface of the landfill. In many instances the material resembled metallurgical and glass industry process waste. Of the eighteen samples, three had levels of U-238 and/or Th-232 over 1000 pCi/g, which is over the .05% or .25% weight percent uranium or thorium content requiring classification for source

materials. Fourteen samples had Ra-226 at 15 pCi/g or above, and several were above 100 pCi/g.

These samples provided more details on the types and concentrations of the radionuclides present at the site. Although the levels are elevated, all radionuclides are in the class of NORM (Naturally Occurring Radioactive Materials) and are probably waste materials. Some of these materials may have been formerly exempt from regulation, and come from various industries in Western New York, others may have been regulated materials that were subsequently improperly disposed. We cannot be certain what the extent of such NORM materials in terms of volume are present at the landfill. The recent survey and samples indicate that while the materials present apparently are located in "hot spots", these "hot spots" are dispersed over most of the site. This would be consistent with continuous disposal of industrial process materials over a period of years in discrete batches of limited volume rather than disposal of very large quantities of ore residues, as has been the case at some other sites.

The DOH lab analysis of four split samples (R-06S, R32S, R-41S, R-72S) showed very good agreement with the DEC contractor results. These samples were intended to check the accuracy of the sample analysis from Clean Harbors laboratory. Table 2-4 is a cross-reference table for the "R" type CDM sample numbers. This table can be used to obtain the DOH and Clean Harbors sample numbers for the split sample results shown on tables 2-5 through 2-7.

3.2 Radium Discs

Six radium discs were found at the site and their analysis appears in Table 2-3. Samples 060189003, 060189002, 8920895388, 8920895341, 8920895342 and 8920895343 are the radium discs. They generally are from 1/2 " to 4 " in diameter and up to 1/2" thick. The high levels of Radium 226 found on these discs, ranging from .8 to 25 micro Ci, is attributed to what is believed to be luminous paint on these objects. All of the discrete objects found at the site have been containerized and secured within the fenced drum storage area on the site.

3.3 Miscellaneous Samples

In addition to soils and radium discs three other types of samples were collected; a bag of green powder, the soil surrounding a disc and a small piece of metal.

The bag of green powder was analyzed and the results of the analysis are reported in Table 2-8, as sample number 339. This material is high in thorium 232 and is thought to be a process waste from either the metallurgical processing or glass processing industries.

Sample 340 from Table 2-8 was the soil surrounding one of the radium discs. The results are very similar to normal background levels for all constituents with the radium 226 being slightly above background, but still within the normal range for radium in soils of .2 to 2.0 pCi/g. This indicates that there is little or no significant leakage of radioactive material from the disc to the soil.

A small metal disc, sample 060189001, was analyzed and this is also shown on Table 2-3. The disc contains uranium and is suspected to be metallurgical waste.

3.4 Radon

The elevated levels of radium - 226 found in some samples at the site in discrete objects as well as soils could lead to the evolution of radon - 222 in soil gas. Normal soil usually contains radium-226 at concentrations of 0.2 to 2 pCi/g, and soil gas Rn-222 concentrations of 200-800 pCi/liter. The radon diffuses through the soil and eventually reaches the atmosphere where levels are typically 0.2-0.5 pCi/liter. Only some of the radon from within about 10 feet of the surface can reach the atmosphere. Once the radon gas reaches the surface dilution occurs and the levels in the atmosphere are only a small fraction of the soil gas radon concentration.

Since the elevated levels of radium-226 identified at the site are located in "hot spots" and are generally beneath the surface, one could expect soil gas radon levels to be elevated in the vicinity of the "hot spots" but not elsewhere. There is no reason to believe that atmospheric radon levels at this site would be any different than off site, and even if somewhat elevated over "hot spots", atmospheric dilution would quickly bring them to normal levels within a short distance.

The NYSDOH radon measurement database developed from the Radon Detector Program, shows the average basement radon level measured in over 200 Cheektowaga homes to be about 2 pCi/liter, which is relatively low. Most of the basements in the Northeast have radon levels in the range of 2 to 10 pCi/liter. Other areas of Erie County, where the local geology is different, have higher basement radon levels.

Although elevated radon levels are not expected adjacent to the landfill, the NYSDOH has provided radon detectors to the homes bordering the landfill, that wish to participate, in order that they may be assured by the analytical results that the site does not pose a radon problem at their homes.

4.0 SUMMARY AND CONCLUSIONS

4.1 Summary

The table below shows the range of typical soil concentrations of natural radionuclides and the fallout fission products of Sr-90 and Cs-137. This reference table can be used as a comparison to the elevated levels found in many of the Pfohl Brothers Landfill soil samples.

Typical Soil Concentrations

<u>Radionuclide</u>	<u>pCi/g (normal soil)</u>
Radium - 226	0.2 - 2
Uranium - 238	0.2 - 2
Thorium - 232	0.2 - 2
Potassium - 40	5 - 50
Cesium - 137	0.2 - 1.0
Sr - 90	0.1 - 0.5

The background samples BKG 1, BKG 2 and 013 taken as part of the investigations were within the levels shown on the table for normal soil levels of radiation. Many of the elevated area soils sampled were many times the background, however, the survey at the site indicated that the large majority of the elevated readings were in areas of only a few square feet indicating the presence of discrete materials.

Uranium and thorium as industrial waste products have been found at other inactive landfills in the State. The source of this contamination, however, is not traceable based on the limited sample data obtained. Current practice is to require licensing and regulated disposal of these materials. However, some users may not be aware of the fact that the materials they use contain radioactivity and thus disposal of such materials may occur along with other waste products.

Several industrial applications of radioactive materials are also exempt from regulation in agreement with Nuclear Regulatory Commission (NRC) regulations. Examples of these follow:

1. Thorium in gas mantles, vacuum tubes, welding rods, lamps (<50 mg/lamp), rare earth metals, compounds or mixtures containing not more than 0.25% by weight of thorium, uranium or any combination of these.
2. Source material (Uranium or Thorium) less than .05% by weight.
3. A) Source material in ceramic glaze products up to 20% by weight.
 B) Glassware or glass enamel frit up to 10% by weight.

The following chart shows equivalent radionuclide activity at up to 20 wt% of U-238 and Th-232.

pCi/g at wt. % of U-238 and Th-232

<u>Radionuclide</u>	<u>.05%</u>	<u>.25%</u>	<u>10%</u>	<u>20%</u>
U-238	167	835	33,400	66,800
Th-232	55	275	11,100	22,000

As one can see, the activities can be quite high. A small quantity of the high activity material can give a large apparent activity to a soil sample. For example say a few grams of the 10% glaze mixed in a 1,000 gm sample of ordinary soil could easily yield U-238 at 30 - 300 pCi/g and Th-232 at 10 - 100 pCi/g.

Ra-226 may also be high in some rare earth compounds. These materials are widely used in glass making and polishing of lenses.

The large variations in radionuclide concentrations present at this site suggest that while there are areas of higher soil activity, it is not uniformly spread throughout the area. The ground surveys also indicate this, since numerous small area "hot spots" were found throughout the site.

Only two materials were found to be widely spread over the site and in large quantities. One was a dark granular coal ash material found in the western side of Area C and running from Aero Drive to the Southern border of the landfill. This material had about twice the background radiation level, as would be expected in coal ash material where the naturally occurring radioactive elements remain and are concentrated after the coal is burned.

The other material was a light brown colored granular material. This material was found at different elevated areas over the site. Sample 017 on Table 2-2 is an analysis of one spot where a bag of this material was found. The results indicate that the material has about 10 times the normal soil levels for radium. In most areas of the site where this material was found it was mixed in with the soils and the radiation levels were only 2-3 times background levels.

4.2 Conclusions

The following conclusions have been reached based on the results of these investigations:

1. The radioactive waste material is stabilized on the surface and subsurface of the landfill and does not present an airborne environmental hazard.
2. Direct contact with the radioactive materials should be discouraged.
3. Radon exposure is expected to occur at normal levels.
4. Since the major routes of access to the site have been fenced and posted with "Hazardous Waste" signs, the potential for direct exposure of the public from on-site contamination will be extremely remote. Therefore, remediation of the radioactive wastes is not required at this time.
5. Should remediation of hazardous waste occur at this site, the impact of radioactive wastes on the remedy must be taken into account in both the technology and the worker health and safety aspects.

TABLES

- 2-1 1988 NYSDOH Soil Sample Results
- 2-2 1988 NYSDEC Soil Sample Results
- 2-3 Discrete Objects Found at the Site
- 2-4 Cross-reference Table for CDM Sample Number, NYSDOH Samples Numbers and Clean Harbors Laboratory Sample Numbers
- 2-5 1989 Soil Sample Results - Other Radionuclides
- 2-6 1989 Soil Sample Results - Thorium Series
- 2-7 1989 Soil Sample Results - Uranium Series
- 2-8 1989 Miscellaneous Samples - green powder and soil surrounding radium disc

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a:tables

TABLE 2-1

Page No. 1
03/14/90

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
TABLE 2-1

SAMPLE UNITS	U-238	THORIUM 232	RADIUM 226	CESIUM 137	POTASSIUM 40
BKG1 pCi/g	1.0 +/- 0.3	0.52 +/- .07	0.46 +/- .09	0.26 +/- .05	13.2 +/- 1.3
BKG2 pCi/g	1.9 +/- 0.5	0.54 +/- .10	0.72 +/- .13	0.21 +/- .05	7.4 +/- 1.3
B-2 pCi/g	6.3 +/- 0.6	1.5 +/- .11	5.3 +/- .30	0.22 +/- .05	4.7 +/- 1.0
B-1 pCi/g	7.7 +/- 0.9	4.8 +/- .20	9.4 +/- .50	0.19 +/- .06	6.0 +/- 1.3

TABLE 2-2

Page No. 1
03/14/90

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
RADIATION BUREAU SOIL SAMPLES 1988 TABLE 2-2

NYDEC SAMPLE NO.	UNITS	GROSS BETA	RADIUM 226	RADIUM 228	THORIUM 228	THORIUM 232	CESIUM 137	MERCURY 203
013	pCi/g	9.6 +/- 4.7	0.6 +/-0.1			0.5 +/- 0.1	0.3 +/- 0.1	
015	pCi/g	23 +/- 5	2.2 +/- 0.3	0.6 +/-0.1	2.6 +/- 0.3	2.6 +/- 0.3		
016	pCi/g	410 +/- 50	94 +/- 10	33 +/- 4	14 +/- 2	14 +/- 2		
017	pCi/g	180 +/- 20	25 +/- 3	8 +/- 0.8	3.5 +/- 0.4	3.5 +/- 0.4		
018	pCi/g	1100 +/-200		410 +/- 50	440 +/- 50	440 +/- 50		
019	pCi/g	9.2 +/-4.6	0.7 +/- 0.1	0.6 +/- 0.1	0.6 +/- 0.1	0.6 +/- 0.1		
020	pCi/g	18 +/- 5	0.7 +/- 0.1	3.9 +/- 0.4	4.3 +/- 0.4	4.3 +/- 0.4	0.3 +/- 0.1	0.1 +/- 0.1

age No. 1
3/14/90

TABLE 2-3

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
DISCRETE OBJECT ACTIVITIES(microCi) TABLE 2-3

YDEC AMPLE O.	UNITS	URANIUM 235	URANIUM 238	RADIUM 226	THALLIUM 210	ACTINIUM 228	LEAD 212	THALLIUM 208
60189003	microCi	LT .004	LT .004	.77 +/- .02	LT .002	LT .011		LT .007
60189002	microCi		LT .500	.89 +/- .02	LT .003	LT .012		LT .008
60189001	microCi	LT .003	.24 +/- .19	LT .004	.011 +/- .002	.230 +/- .02	.21 +/- .07	.19 +/- .01
21289003	microCi	.0003	LT .004	.0052	LT .00002	LT .0001	.00029	LT .00007
21289015	microCi	.00004	LT .004	.0043	LT .00002	LT .00009	.00017	LT .00007
920895338	microCi			8.7 +/- 1.1				
920895341	microCi			24 +/- 3				
920895342	microCi			25 +/- 3				
920895343	microCi			9.4 +/- 1.1				

TABLE 2-4

Page No. 1
03/14/90

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
CROSSREFERENCE TABLE 2-4

CDM SAMPLE NO.	UNITS	MATRIX	SAMPLE NO.	
R-06	pCi/g	SOIL/WASTE	121289001	R-06
R-15	pCi/g	SOIL/WASTE	121289002	R-15
R-22	pCi/g	SOIL/WASTE	121289004	R-22
R-24	pCi/g	SOIL/WASTE	121289005	R-24
R-26	pCi/g	SOIL/WASTE	121289006	R-26
R-29	pCi/g	SOIL/WASTE	121289007	R-29
R-31	pCi/g	SOIL/WASTE	121289008	R-31
R-35	pCi/g	SOIL/WASTE	121289009	R-35
R-40	pCi/g	SOIL/WASTE	121289010	R-40
R-41	pCi/g	SOIL/WASTE	121289011	R-41
R-47	pCi/g	SOIL/WASTE	121289012	R-47
R-49	pCi/g	SOIL/WASTE	121289013	R-49
R-61	pCi/g	SOIL/WASTE	121289014	R-61
R-72	pCi/g	SOIL/WASTE	121289016	R-72
R-73	pCi/g	SOIL/WASTE	121289017	R-73
R-75	pCi/g	SOIL/WASTE	121289018	R-75
R-06S	pCi/g	SOIL/WASTE	DOH95409	R-06S
R-31S	pCi/g	SOIL/WASTE	DOH95408	R-31S
R-41S	pCi/g	SOIL/WASTE	DOH95410	R-41S
R-72S	pCi/g	SOIL/WASTE	DOH95411	R-72S

TABLE 2-5

Page No. 1
03/14/90

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
OTHER RADIONUCLIDES TABLE 2-5

SAMPLE NUMBER	CDM SAMPLE NO.	UNITS	CO-60	K-40	CS-137
121289001	R-06	pCi/g	LT 1.1	LT 12	LT 1.1
121289002	R-15	pCi/g	LT 0.4	LT 4	LT 0.4
121289004	R-22	pCi/g	LT 1.2	24 +/- 13	LT 1.2
121289005	R-24	pCi/g	LT 0.6	14 +/- 6	LT 0.6
121289006	R-26	pCi/g	LT 0.2	2 +/- 2	LT 0.2
121289007	R-29	pCi/g	LT 0.2	11 +/- 4	LT 0.3
121289008	R-31	pCi/g	LT 0.2	LT 2	LT 0.15
121289009	R-35	pCi/g	LT 0.15	2 +/- 2	LT 0.2
121289010	R-40	pCi/g	LT 5	230 +/- 50	LT 6
121289011	R-41	pCi/g	LT 3	300 +/- 30	LT 4
121289012	R-47	pCi/g	LT 0.4	LT 4	LT 0.4
121289013	R-49	pCi/g	LT 0.09	3 +/- 2	.22 +/- .15
121289014	R-61	pCi/g	LT 4	LT 40	LT 4
121289016	R-72	pCi/g	LT 0.5	LT 7	LT 0.5
121289017	R-73	pCi/g	LT 0.13	LT 1.4	LT 0.14
121289018	R-75	pCi/g	LT 0.2	5 +/- 3	LT 0.2
DOH95409	R-06S	pCi/g		5.6 +/- 1.2	0.2 +/- 0.1
DOH95408	R-31S	pCi/g		LT 0.3	LT 0.02
DOH95410	R-41S	pCi/g		LT 60	LT 3
DOH95411	R-72S	pCi/g		4.2 +/- 0.9	LT 0.06

TABLE 2-6

Page No. 1
03/14/90

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
THORIUM SERIES TABLE 2-6

SAMPLE NUMBER	CDM SAMPLE NO.	UNITS	ACT-228	PB-212	TL-208
121289001	R-06	pCi/g	LT 5	7 +/- 3	6 +/- 3
121289002	R-15	pCi/g	14 +/- 2	14 +/- 1.2	11.9 +/- 1.5
121289004	R-22	pCi/g	LT 4	10 +/- 3	LT 3
121289005	R-24	pCi/g	LT 3	9 +/- 2	LT 2
121289006	R-26	pCi/g	3.3 +/- 0.9	3.6 +/- 0.5	2.5 +/- 0.8
121289007	R-29	pCi/g	8 +/- 2	7.5 +/- 0.8	6.2 +/- 1.1
121289008	R-31	pCi/g	1.4 +/- 0.8	0.9 +/- 0.3	1.2 +/- 0.5
121289009	R-35	pCi/g	4.2 +/- 0.9	3.1 +/- 0.5	3.1 +/- 0.7
121289010	R-40	pCi/g	3330 +/- 60	3370 +/- 30	2790 +/- 40
121289011	R-41	pCi/g	3680 +/- 30	3249 +/- 14	3340 +/- 20
121289012	R-47	pCi/g	9 +/- 2	8.5 +/- 1.1	9 +/- 1.5
121289013	R-49	pCi/g	1.4 +/- 0.6	0.8 +/- 0.2	0.9 +/- 0.4
121289014	R-61	pCi/g	19 +/- 14	115 +/- 8	25 +/- 10
121289016	R-72	pCi/g	6 +/- 3	6.3 +/- 1.4	7 +/- 2
121289017	R-73	pCi/g	4.5 +/- .7	3.4 +/- 0.4	3.7 +/- 0.5
121289018	R-75	pCi/g	3.9 +/- 1	3.7 +/- 0.6	3.2 +/- 0.8

TABLE 2-7

Page No.
03/14/90

1

RADIONUCLIDE ANALYSIS RESULTS
PFOHL BROTHERS LANDFILL 09-15-043
CHEEKTOWAGA N.Y., ERIE CO.
URANIUM SERIES TABLE 2-7

SAMPLE NO.	UNITS	U-238	RA-226	MEDIA
121289001	pCi/g	LT 200	445+/-6	SOIL/WASTE
121289002	pCi/g	140 +/- 70	69 +/-2	SOIL/WASTE
121289004	pCi/g	LT 200	235 +/-6	SOIL/WASTE
121289005	pCi/g	LT 98	227 +/- 3	SOIL/WASTE
121289006	pCi/g	40 +/- 30	15 +/- 0.9	SOIL/WASTE
121289007	pCi/g	LT 40	26.9 +/-1.3	SOIL/WASTE
121289008	pCi/g	LT 20	2.7 +/-0.5	SOIL/WASTE
121289009	pCi/g	LT 30	13.6 +/-0.8	SOIL/WASTE
121289010	pCi/g	LT 600	15 +/- 12	SOIL/WASTE
121289011	pCi/g	LT 400	15 +/- 8	SOIL/WASTE
121289012	pCi/g	120 +/- 60	48 +/- 2	SOIL/WASTE
121289013	pCi/g	LT 20	1.2 +/- 0.3	SOIL/WASTE
121289014	pCi/g	6400 +/-600	3339+/- 15	SOIL/WASTE
121289016	pCi/g	LT 90	23 +/- 2	SOIL/WASTE
121289017	pCi/g	40 +/- 20	23.3 +/- .6	SOIL/WASTE
121289018	pCi/g	LT 30	11.3 +/- .8	SOIL/WASTE
DOH95409	pCi/g	LT 1.2	258 +/- 9	SOIL/WASTE
DOH95408	pCi/g	2.7 +/- 0.4	2.5 +/- 0.2	SOIL/WASTE
DOH95410	pCi/g	340 +/- 50	17 +/- 6	SOIL/WASTE
DOH95411	pCi/g	24 +/- 1	30.6+/- 1	SOIL/WASTE

TABLE 2-8

03/19/90

RADIONUCLIDE ANALYSIS RESULTS
 PFOHL BROTHERS LANDFILL 09-15-043
 CHEEKTOWAGA N.Y., ERIE CO.
 MISCELLANEOUS SAMPLES TABLE 2-8

SAMPLE UNITS	U-238	THORIUM 232	RADIUM 226	CESIUM 137	POTASSIUM 40
339 pCi/g		1930 +/-60			
340 pCi/g	1.0 +/- 0.3	0.59 +/- .12	1.84 +/- .13	0.21 +/- .03	5.2 +/- 0.7