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300-FF-1 Operable Unit Remedial Investigation Phase II Report: Physical Separation of Soils Treatability Study

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ACRONYMS

ARAR	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	United States Department of Energy
RL	Richland Operations Office
dpm	disintegration per minute
DQO	data quality objectives
ECN	Engineering Change Notice
Ecology	Washington State Department of Ecology
EII	Environmental Investigation Instructions
EPA	United States Environmental Protection Agency
FS	Feasibility Study
HEIS	Hanford Environmental Information System
ICP-OES	inductively coupled plasma - optical emission spectrometry
ICP-MS	inductively coupled plasma - mass spectrometry
ICR	incremental cancer risk
IT	International Technologies Laboratories
LSA	low specific activity
MTCA	Model Toxics Control Act
ORR	Operational Readiness Review
PCB	polychlorinated biphenyls
PNL	Pacific Northwest Laboratory
QA	quality assurance
QC	quality control
RI	remedial investigation
ROD	Record of Decision
TCLP	Toxicity Characteristic Leaching Procedure
USACE	United States Army Corps of Engineers
WHC	Westinghouse Hanford Company
XRD	X-ray diffraction
XRF	X-ray fluorescence

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1.0 INTRODUCTION

This report is in fulfillment of *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) Milestone M-15-03B to submit the draft 300-FF-1 Remedial Investigation Phase II report to the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) for review by December 15, 1993 (Ecology et al., 1989). The report describes the approach and results of physical separations treatability tests conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) at the Hanford Site (Figure 1-1) in the North Process Pond of the 300-FF-1 Operable Unit (OU) (Figure 1-2). Physical separation was identified in the Phase I and II Feasibility Study Report for the 300-FF-1 Operable Unit (DOE-RL 1993a) as a potential alternative for remediation for which treatability studies were required. Following treatability studies, physical separation of soils will be further assessed in Phase III Feasibility Studies.

Because soil and contaminant characteristics are similar in other waste sites, test results should apply to all the soils in waste sites within the 300-FF-1 OU. However, the scope of this report is limited to investigations and discussions of the North Process Pond.

Tests were conducted by Westinghouse Hanford Company (WHC) personnel using a system developed at Hanford consisting of modified EPA equipment integrated with screens, hoppers, conveyors, tanks, and pumps from the Hanford Site. The EPA equipment was transferred to the U.S. Department of Energy (DOE) by the EPA Risk Reduction Engineering Laboratory to conduct the tests (Appendix A). Tests were conducted in accordance with the 300-FF-1 Physical Separations CERCLA Treatability Test Plan (DOE-RL 1993b). Under CERCLA, no federal, state, or local permits were required (40 CFR 300.400[e][1]).

Analytical support was provided by International Technologies and Data-Chem laboratories, except for toxic characteristic leach procedures, which were provided by TMA, Inc. Sieving, screening analyses, and laboratory attrition scrubbing support was provided by Pacific Northwest Laboratory (PNL).

Because of delays, additional testing scheduled could not be performed until after preparation of this report. The purpose of additional testing will be to assess a different system, compare results with this report, and test soils that previously did not yield favorable results. Upon completion, results of the additional tests will be included in a revision to this report.

The treatability tests discussed in this report consisted of four parts: (1) a pre-test run to set up the system and adjust system parameters for soils to be processed, (2) a baseline run to establish the performance of the system, (3) a final run in which the system was modified as a result of findings from the baseline run, and (4) water treatment. This report contains procedures, results, field changes from the test plan (DOE-RL 1993b), discussion of results, and recommendations for future tests.

Figure 1-1. The Hanford Site, Richland, Washington.

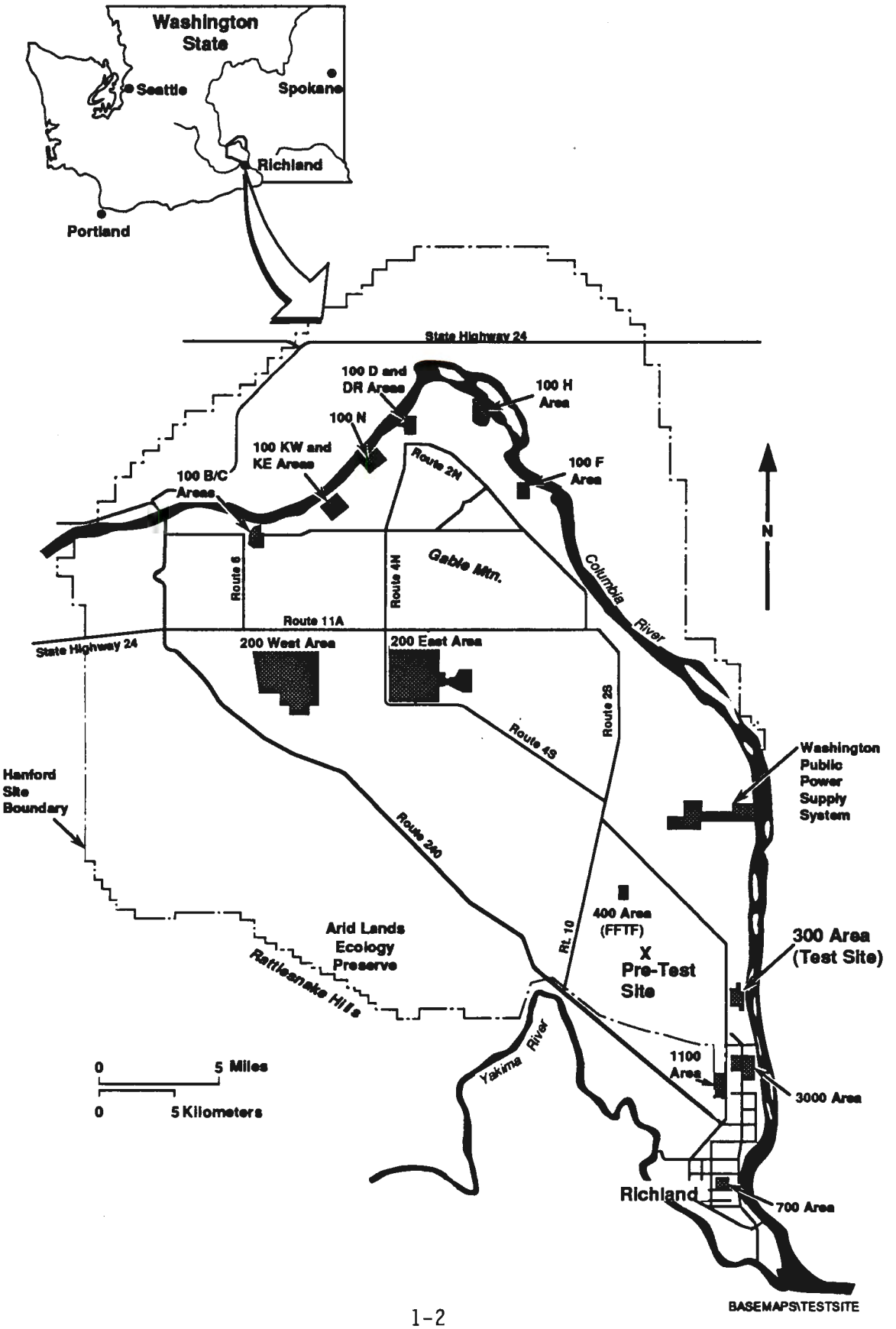
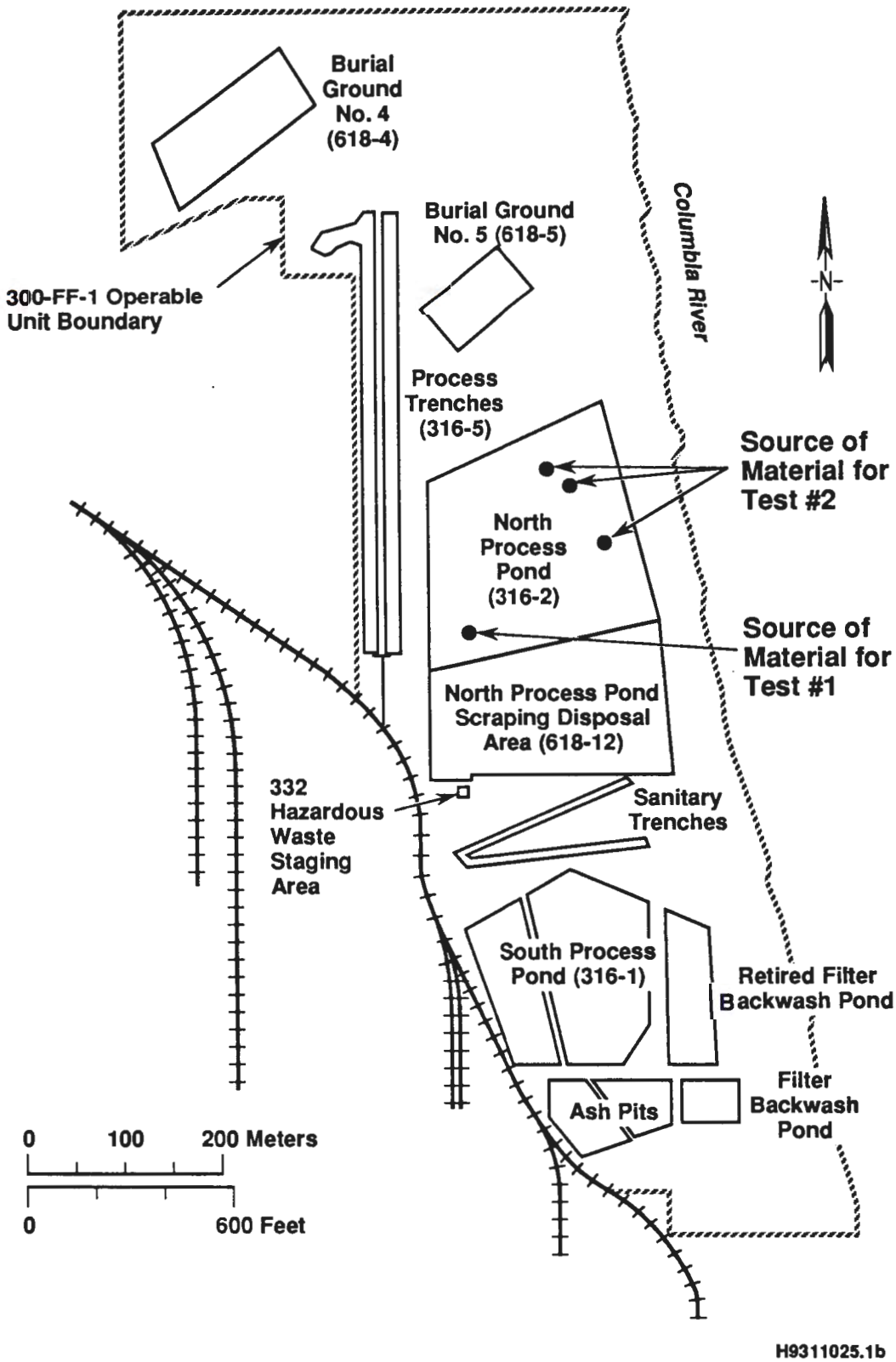


Figure 1-2. The 300-FF-1 Operable Unit, North Process Pond.



1.1 SITE DESCRIPTION

The 300-FF-1 OU consists of approximately 0.14 km^2 of liquid disposal sites (i.e., unlined trenches and ponds). It is located north of the city of Richland, Washington, and borders the Columbia River (see Figure 1-2). The depth to groundwater beneath the North Process Pond ranges from 12 to 20 m (DOE-RL 1990).

A more detailed description of the 300-FF-1 OU is included in the *Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1990), and the *Phase I Remedial Investigation Report for the 300-FF-1 Operable Unit* (DOE-RL 1993c).

1.2 HISTORY OF OPERATIONS

Ponds and trenches in the 300-FF-1 OU were constructed in 1948 to receive process sewer waste that included process water from nuclear fuels fabrication operations, cooling water, steam condensate, water treatment salts, and a wide variety of waste liquids from laboratory drains throughout the 300 Area. Parts of the North Process Pond were used to dispose of fly ash from the 300 Area ashpits (Dennison et al. 1989). The ponds were deactivated in 1975 and currently do not contain any liquids.

Additional detail regarding the 300-FF-1 OU and the North Process Pond is included in the Work Plan (DOE-RL 1990) and the Phase I remedial investigation (RI) report.

1.3 WASTE STREAM DESCRIPTION

Phase I remedial investigation field activities to characterize the 300-FF-1 OU waste sites were completed February 1992. Soils investigations included surface radiation surveys and analysis of samples collected from boreholes and test pits. Results of these investigations are reported in DOE-RL (1993c).

1.3.1 Performance Levels and Risk Drivers

The minimum contaminant concentrations or performance levels established as a goal for the test and background levels for contaminants identified in the test plan (DOE-RL 1993b) are shown in Table 1-1. These contaminants were determined to include the primary risk drivers identified in Phase I remedial investigations (DOE-RL 1993c).

On the basis of these soil investigations and the risk assessment presented in the Phase I RI report, uranium is the primary contaminant of concern for 300-FF-1 OU. Uranium-238 and uranium-235 pose the highest lifetime incremental cancer risk (ICR) (2E-03 and 1E-03 respectively [DOE-RL 1993c]). Cobalt-60 is also an important contaminant with a lifetime cancer risk of 2E-04.

Table 1-1. Background Levels of Contaminants and Minimum Performance Levels for Soil Treatability Tests.

Analyte	Units	Background Levels[c]	Test Performance Levels
Metals (inorganics)[a]	mg/kg		
Aluminum		3,070	NA
Antimony		5.01	128
Arsenic		0.59	320
Beryllium		0.25	172
Cadmium		0.59	320
Chromium		5.0	1,600
Copper		10.7	11,840
Iron		11,300	NA
Lead		1.55	4,480
Manganese		189	64,000
Mercury		0.049	96
Nickel		3.8	6,400
Silver		1.53	960
Zinc		11.5	64,000
Organics[a]	mg/kg		2.2
1,2-		0	6,400
dichloroethylene		0	0.3
Methylene		0	2.04
chloride		0	0.44
Tetrachloroethylene			2.2
Trichloroethylene			
	pCi/g		
PCB			
Radiochemical		0	30
Contaminants[b]		0	7.1
		0	170
Cesium-137		0	370
Cobalt-60			
Uranium-235			
Uranium-238			

[a]Performance levels for inorganic and organic contaminants are from MTCA (WAC 173-340.740(4)).

[b]Performance levels for radionuclides are from WHC (1991).

[c]Background levels are values used for risk calculations from Phase I RI Report (DOE-RL 1993c). A value of "0" was used for risk assessments for all organics, PCBs, and radionuclides.

Uranium-238, uranium-235 and cobalt-60 are the only contaminants in the operable unit with ICRs over 1E-04. According to the National Oil and Hazardous Substances Contingency Plan (40 CFR 300.430[c][2][i][A][2]) and *Hanford Site Baseline Risk Assessment Methodology* (DOE-RL 1993d), acceptable exposure levels are generally concentration levels that represent an ICR of between 1E-04 and 1E-06 (DOE-RL 1993d). It is noted that a radioactive contaminant concentration level associated with an ICR of 1E-04 or less is small enough to ensure satisfaction of any current radiation protection standards (e.g., DOE Order 5400.5) pertinent to the Hanford Site (DOE-RL 1993d).

The highest ICR posed by inorganic contaminants is due to chromium (2E-05); this risk is two orders of magnitude less than that for ^{238}U. The remaining inorganic and organic contaminants (including polychlorinated biphenyls [PCB]) are associated with ICRs more than two orders of magnitude less than the risk calculated for ^{238}U.

According to the National Oil and Hazardous Substances Contingency Plan (40 CFR 300.430[c][2][i][A][2]) and DOE-RL (1993d), acceptable exposure levels of systemic toxins are concentration levels to which human populations, including sensitive subgroups, may be exposed without adverse effects during a lifetime or part of a lifetime (i.e, the hazard quotient has a value less than or equal to one). For the 300-FF-1 OU, the largest hazard quotient is 0.4, indicating that none of the contaminants pose a systemic toxic hazard.

1.3.2 Radioactivity of Soils

Radioactivity levels in soils near the inlet end and on the west side of the North Process Pond ranged from 10,000 to 30,000 disintegration per minute (dpm/100 cm^2) as measured in the field in tests conducted during June 1993 (Section 3.0). It is estimated that soils containing this level of radioactivity comprise less than 1/4 of the ground surface area of the ponds shown in Figure 1-1.

The surface radioactivity levels of soils in the remaining portions of the North Pond were measured at near background levels (500 dpm). These measurements are consistent with Phase I RI sampling results showing near background radioactivity levels in test pits in the middle and east side of the trench.

The highest radioactivity in the North Process Pond is found in particles, visible as a "green material," containing ^{238}U and ^{235}U isotopes. The "green material" is deposited in thin layers at a depth of 1 to 1.5 m below the pond surface on the west side of the pond (Dennison et al. 1989) and distributed as discrete particles and flakes in soils near the inlet of the ponds. This material resulted in many test complications discussed in Sections 2.0 and 3.0. The "green material" is described in Section 3.2.1.

1.3.3 Soil Characterization and Treatment Tests

Bench-scale wet-sieved tests and soil characterization tests using material from the North Process Pond were performed by PNL (Gerber et al. 1991). In the PNL tests, small soil particles were washed through sieves using water and chemical solutions. The results suggested that it is possible to separate coarse soil particles from fine soil particles with higher concentrations of contaminants. Although concentrated, contaminant levels of the fine particles were still low enough (Gerber et al. 1991) that there were no added problems related to handling or exposure to these soils. Also, in these tests, contaminants did not dissolve into the wash water; thus, water treatment needs were expected to be minimal. Testing of larger scale equipment was recommended to assess application of the technology to more coarse soils (Gerber et al. 1991).

X-ray diffraction (XRD) tests (Dennison et al. 1989) show that the mineralogical composition of the sediment is typical of sediments found throughout the Pasco Basin that consist predominantly of quartz and feldspar with small amounts of clay and mica.

Soil samples collected as part of Phase I RI for the 300-FF-1 OU were dry sieved and analyzed by Serne et al. (1992) to determine soil particle size distribution and contaminant distribution. Results, summarized in Tables 1-2, 1-3, and 1-4, show that the highest concentration of contaminants is in the fine soil particles. Based on performance levels specified in the test plan for this test (see Table 1-1), physical separation at a size fraction of 0.425 mm may reduce the amount of contaminated soil in the North Process Pond by 90% (by weight) or more. A greater reduction in the amount of contaminated soils will be realized if soils can be separated at a smaller size fraction.

1.4 REMEDIAL TECHNOLOGY DESCRIPTION

In this document, physical separation refers to a simple and comparatively low-cost water-based technology to separate soil particles by size fraction without the use of chemical processes so that the coarse fraction of soil will meet cleanup limits (test performance levels for the treatability test) and the amount of contaminated soils is significantly reduced.

Physical separation processes for soils are used extensively in the mining and mineral industries to assist in the recovery of valuable constituents. These physical separation processes have been demonstrated by the EPA Superfund Innovative Technology Evaluation Program for hazardous waste remediation (EPA 1989) and used by the Defense Nuclear Agency to remediate radiologically contaminated coral sands (Kochen 1986). The technology was successfully applied in September 1993 to remediate chromium contaminated soils at the King of Prussia Superfund Site in Winslow County, New Jersey (Rubin 1993). Additional information on physical separation processes is provided by EPA in *Technological Approaches to the Cleanup of Radiologically Contaminated Superfund Sites* (EPA 1988).

Table 1-2 300-FF-1 North Pond Particle Size Distribution. (Serne et al. 1992)

	FRACTION SIZES (mm)												
	>50	50 to 37.5	37.5 to 25	25.0 to 13.2	13.2 to 4.75	4.75 to 2.0	2.0 to 0.425	0.425 to 0.25	0.25 to 0.15	0.15 to 0.075	0.075 to 0.045	<0.045	Totals
Sam. 1 (g)	238.48	655.89	690.83	495.57	153.95	206.92	556.20	47.43	21.26	12.54	5.38	1.76	3086.21
Sam. 2 (g)	1050.08	270.96	387.31	278.75	244.93	125.78	488.21	145.39	57.63	46.32	28.77	46.51	3170.64
Sam. 3 (g)	620.32	127.61	917.82	358.37	174.51	138.45	812.37	28.55	44.54	31.62	22.66	39.25	3316.07
Tot. Wt.(g)	1908.88	1054.46	1995.96	1132.69	573.39	471.15	1856.78	221.37	123.43	90.48	56.81	87.52	9572.92
Pct. By Wt.	19.94%	11.02%	20.85%	11.83%	5.99%	4.92%	19.40%	2.31%	1.29%	0.95%	0.59%	0.91%	100.00%

Table 1-3 300-FF-1 North Pond Radiochemical Contaminants by Size Fraction. (Serne et al., 1992)

	FRACTION SIZES (mm)											
	>50	50 to 37.5	37.5 to 25	25.0 to 13.2	13.2 to 4.75	4.75 to 2.0	2.0 to 0.425	0.425 to 0.25	0.25 to 0.15	0.15 to 0.075	0.075 to 0.045	<0.045
Uranium-235												
(pCi/g) - 1	0.0408	0.0618	0.213	0.275	0.352	1.29	2.95	10.20	14.70	23.00	26.50	34.10
(pCi/g) - 2	0.0158	0.0765	0.113	0.117	0.291	1.13	1.02	3.05	5.07	6.69	7.99	8.09
(pCi/g) - 3	0.0362	0.0135	0.184	0.184	0.523	1.21	0.81	1.95	1.56	2.41	4.23	3.63
(pCi/g) - Avg.	0.0256	0.0597	0.180	0.207	0.378	1.22	1.51	4.44	5.46	7.45	8.24	6.61
Uranium-238												
(pCi/g) - 1	0.484	0.394	2.01	2.11	9.09	18.40	45.10	138.00	195.00	384.00	493.00	592.00
(pCi/g) - 2	0.254	0.576	2.74	1.10	1.39	14.10	15.50	51.90	105.00	158.00	151.00	167.00
(pCi/g) - 3	0.409	0.159	0.73	1.14	2.48	9.63	7.01	37.60	30.20	44.80	52.20	59.60
(pCi/g) - Avg.	0.333	0.412	1.56	1.55	3.79	14.67	20.65	68.50	93.51	149.76	143.98	127.38
Cobalt-60												
(pCi/g) - 1	0.10	0.10	0.10	0.10	0.10	0.10	0.66	0.100	0.10	0.10	0.10	0.10
(pCi/g) - 2	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.599	0.10	0.10	0.10	0.10
(pCi/g) - 3	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.100	0.10	1.20	3.57	0.10
(pCi/g) - Avg.	0.10	0.10	0.10	0.10	0.10	0.10	0.27	0.428	0.10	0.48	1.48	0.10
Cesium-137												
(pCi/g) - 1	0.10	0.104	0.16	0.10	0.10	0.10	0.742	0.100	0.10	0.10	0.10	0.10
(pCi/g) - 2	0.10	0.115	0.10	0.10	0.10	0.10	0.100	0.785	2.42	0.10	0.10	0.10
(pCi/g) - 3	0.10	0.100	0.10	0.10	0.10	0.10	1.440	0.100	0.10	2.07	0.10	0.10
(pCi/g) - Avg.	0.10	0.106	0.12	0.10	0.10	0.10	0.879	0.550	1.18	0.79	0.10	0.10

Table 1-4 300-FF-1 North Pond Chemical Contaminants by Size Fraction (Serne et al. 1992).

ANALYSES OF METALS IN EACH SIZE FRACTION (weighted averages)												
	FRACTION SIZES (mm)											
	*>50	*50 to 37.5	*37.5 to 25	*25.0 to 13.2	13.2 to 4.75	4.75 to 2.0	2.0 to 0.425	0.425 to 0.25	0.25 to 0.15	0.15 to 0.075	0.075 to 0.045	<0.045
Cr (ppm) - Avg.	42.52	73.56	61.86	64.97	52.42	43.45	79.16	164.35	257.37	386.28	496.81	776.74
Mn (ppm) - Avg.	985.59	1271.05	1290.62	1259.52	1098.24	2489.10	1504.14	1296.83	1627.82	1560.16	1554.08	1585.17
Ni (ppm) - Avg.	46.65	65.76	58.53	60.46	52.74	58.70	90.60	114.70	171.17	223.41	261.10	372.98
Cu (ppm) - Avg.	180.60	366.61	282.95	307.96	237.64	483.87	1137.89	1521.44	2312.87	3018.11	3162.26	3007.98
Zn (ppm) - Avg.	80.14	97.30	110.04	102.74	88.88	111.11	133.54	114.13	147.38	163.46	185.03	227.04
Hg (ppm) - Avg.	2.48	2.71	2.72	2.70	2.57	2.84	3.00	2.87	2.95	5.17	6.41	8.62
Se (ppm) - Avg.	0.78	0.85	0.85	0.84	0.81	0.88	0.91	0.83	0.80	1.04	0.87	0.98
Pb (ppm) - Avg.	9.33	8.15	8.40	8.37	8.92	12.55	13.26	21.84	31.26	40.90	50.98	64.96
As (ppm) - Avg.	1.45	1.48	1.45	1.46	1.45	2.29	2.70	4.41	6.36	8.18	9.74	10.67
Ag (ppm) - Avg.	5.22	5.63	5.83	5.70	5.41	5.30	8.56	33.57	66.51	92.84	119.36	177.45
Cd (ppm) - Avg.	5.11	5.15	5.31	5.23	5.15	5.51	5.12	5.14	5.50	5.47	7.10	6.14
Ba (ppm) - Avg.	274.45	135.00	316.03	241.72	251.76	846.12	660.69	743.81	843.61	840.05	840.98	923.60
U (ppm) - Avg.	11.19	23.42	18.44	19.84	15.03	19.64	55.06	161.18	255.14	366.45	402.16	418.16

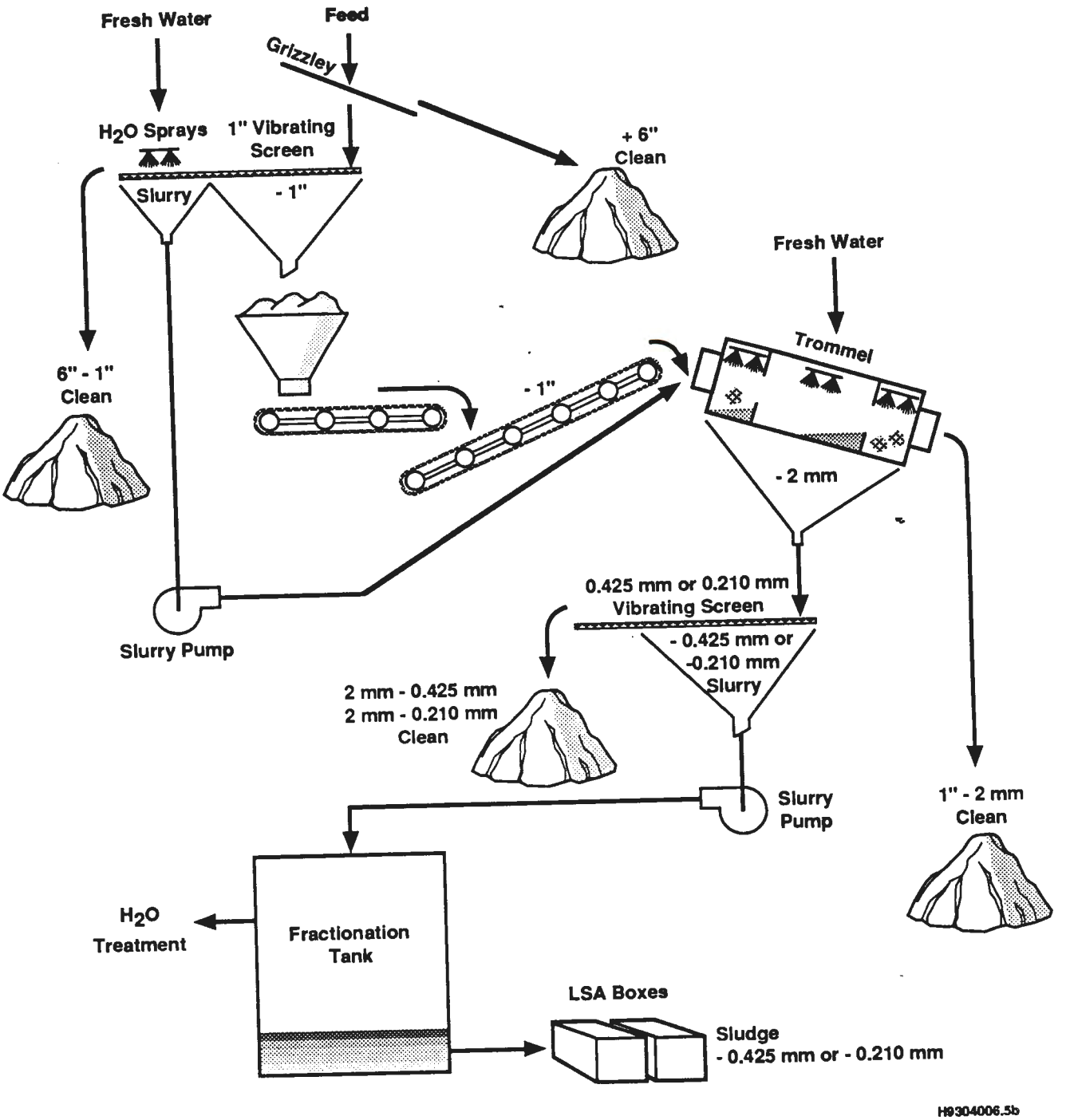
* The four largest size fractions were not analyzed due to the size of the material.
Values are assumed to equal that of the largest fraction analyzed (13.2-4.75) (Serne et al., 1992).

Many physical separations systems are commercially available but were not used for these tests because services and equipment could not be obtained in a timely manner to meet the Tri-Party Agreement milestone for the test. However, many of these systems utilize similar processes to make the physical size separations of soils. Therefore, a system composed of some of these same processes was assembled by WHC personnel (Figure 1-3). The system was designed using available equipment and processes in order to conduct field tests and obtain process information. It was not designed for long-term use, or as a well-integrated system.

The system consisted of the following:

- 150 mm bar screen (grizzly) to separate out material larger than 150 mm
- hopper and 25-mm vibrating screen with water sprays to separate material >25 mm
- belt conveyor to move <25-mm size particles from the hopper to a trommel

Figure 1-3. EPA Modified Physical Separation/Soil-Washing System.



- trommel with water knives to wash >2 mm soils and screen material <2 mm in diameter
- second vibrating screen with a United States National Bureau of Standards (US) #40 or US #70 wire mesh screen to separate particles
- fractionation tanks to contain effluent and fines < 0.425 mm and serve as settling tanks
- off-line water treatment process
- low specific activity (LSA) boxes to contain <0.425-mm particles.

The soils of the Hanford Site are predominantly coarse granitic sands and gravels with <5% silts and clay. It is estimated that contaminated soil volumes in the 300 Area at Hanford could be reduced by 90% or more by separating coarse "clean" soils from contaminated soils (Serne et al. 1992). The "clean fractions" that meet cleanup or release limits (to be determined by the EPA and the Washington State Department of Ecology) would be returned to their original locations. Less than 10% of the soil residuals would require additional treatment/disposal.

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2.0 TREATABILITY STUDY APPROACH

2.1 TEST OBJECTIVES AND RATIONALE

The objective of these tests was to evaluate the use of water-based physical separations systems as a means of concentrating chemical and radiochemical contaminants into fine soil fractions and thereby minimizing the amount of contaminated soils.

The purpose of the test was not to prove or disprove the technology but to determine its effectiveness in reducing the amount of contaminated material in the 300-FF-1 OU.

To date, no specific applicable, relevant, or appropriate requirements (ARAR) have been established for radioactive soils; therefore, DOE Orders and WHC control manual standards were used as minimum goals for the test. The only potential ARAR that is chemical-specific is the *Model Toxics Control Act* (MTCA) (RCW 70.105D). Table 2-1 lists potential chemical-, location-, and action-specific ARARs to the soil treatability test. A final set of ARARs will be identified in the 300-FF-1 OU Phase III Feasibility Study (FS) to be written at a later date.

Minimum goals for the treatability test included:

- 90% or greater weight reduction of contaminated soils (based on Serne et al. 1992)
- The clean fraction (90%) must meet minimum performance levels shown in Table 1-1. These levels should not be considered as cleanup levels, which are yet to be established for Hanford soils, and are less than or equal to:
  - <20 μR/hr above background radioactivity (DOE 1990)
  - The Residual Radioactivity Program, Version 4.0, <25 mRem/hr (Gilbert et al. 1989).
  - WHC radioactive threshold concentrations for accessible soils (WHC 1991)
  - MTCA (RCW 70.105D), Method C, soil cleanup levels.
- Perform analyses consistent with applicable EPA methods (EPA 1990) and test plan requirements.

Water treatment was a secondary objective for the test. The primary goal of water treatment tests was to treat processed effluent to meet purgewater acceptance standards (Appendix A) so that water can be recycled in a full-scale system, and process water generated during the tests can be handled as purgewater (DOE-RL 1993b).

Table 2-1. Potential ARARs for the Soil Treatability Test (sheet 1 of 2)

REGULATION	CITATION	APPLICABILITY
FEDERAL		
Safe Drinking Water Act	42 USC 300F et seq.	Potentially Relevant and Appropriate
Clean Water Act	33 USC 1251 et seq.	Potentially Relevant and Appropriate
Wild and Scenic Rivers	PL 100-605	APPLICABLE
National Primary Drinking Water Regulations	40 CFR 141	Potentially Relevant and Appropriate
Clean Air Act	10 CFR 20	APPLICABLE
National Ambient Air Quality Standards	40 CFR 50	APPLICABLE
National Emissions Standards for Hazardous Air Pollutants	40 CFR 61	APPLICABLE
New Sources Performance Standards	40 CFR 60	Potentially Relevant and Appropriate
Toxic Substances Control Act	15 USC 2601 et seq.	Potentially Relevant and Appropriate
PCB restrictions	40 CFR 761	
Atomic Energy Act	42 USC 2011 et seq.	Potentially Relevant and Appropriate
Uranium Mill Tailings Act	40 CFR 191-192	Potentially Relevant and Appropriate
Environmental Standards for Management, Storage and Disposal of Low Level Radioactive Waste	40 CFR 193	APPLICABLE
Radiation Protection of the Environment	DOE Order 5400.5 DOE Order 5820.2A	To Be Considered To Be Considered
National Historic Preservation Act	16 USC 470 et seq.	APPLICABLE
Endangered Species Act	16 USC 1531 et seq.	Potentially Relevant and Appropriate
Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	40 CFR 264	APPLICABLE
Listed Waste Restrictions	40 CFR 268	APPLICABLE
STATE		
Dangerous Waste Regulations	Ch. 173-303 WAC	APPLICABLE
MTCA Cleanup Regulations	Ch. 173-340 WAC	APPLICABLE
Minimum Functional Standards for Solid Waste Handling	Ch. 173-304 WAC	APPLICABLE
Water Pollution Control	Ch. 90.48 RCW	APPLICABLE
State Waste Discharge Permit Program	Ch. 173-216 WAC	APPLICABLE
Water Quality Standards for the State of Washington	Ch. 173-201 WAC	APPLICABLE

Table 2-1. Potential ARARs for the Soil Treatability Test.
(sheet 2 of 2)

REGULATION	CITATION	APPLICABILITY
Ambient Air Quality Standards and Emission Limits for Radionuclides	Ch. 173-480 WAC	APPLICABLE
Radiation Protection - Air Emissions	Ch. 246-247 WAC	APPLICABLE
Toxic Air Pollutants	Ch. 173-460 WAC	APPLICABLE
Washington Clean Air Act	Ch. 70.94 RCW	APPLICABLE

* As proposed by Ecology.

The primary sampling and analysis data quality objectives (DQO) were to:

- determine physical characteristics of soils
- determine the distribution and concentration of contaminants in the soils before and after a physical separation is made between the coarse material and the fine material
- evaluate separation efficiencies in relation to process parameters
- after processing, determine the concentration of contaminants of concern in the process water, both suspended and dissolved, and evaluate the effectiveness of water treatment methods
- obtain samples and analytical results of sufficient quality to document performance of the system or systems tested and determine if cleanup criteria can be met.

The following questions were answered by the treatability tests. (applicable sections that address these areas are in parentheses):

1. Are agglomerates completely dispersed during processing? If not, what means are necessary to separate agglomerated material adequately? (Section 3.3.2)

2. Are the coarse fractions cleanly separated from the fines? (Sections 3.2.2, 3.3.2)

3. What, if any, treatment is required for large materials? (Section 3.2.1)

4. What are the operating costs? (Section 4.0)

5. To what extent do soluble contaminants build up in the recycle water? (This is key to determining what water treatment will be required for internal water recycle streams and for the reject water stream.) (Sections 3.2.2, 3.3.2, 3.4)

6. How much will it cost to purchase and operate a full-scale (>100 t/hr) plant? (Sections 4.0, 5.0)

7. As a preliminary assessment only, is there any possibility that an indicator analyte, such as ^{238}U, could be used during final remediation to verify cleanup standards are met, thus eliminating the need and cost to analyze for all contaminants of concern? (Section 5.0)

2.2 DESIGN AND PROCEDURES

The treatability test consisted of four parts: the pretest run, Test #1 run, Test #2 run, and water treatment. An estimated 75 tons of soil was processed in the three runs.

2.2.1 Pre-Test

The pretest was conducted in a clean, uncontaminated area located approximately 3.2 km northwest of the 300-FF-1 OU (see Figure 1-1). The pretest was a "shakedown run" of the physical separations prototype system. Approximately 35 tons of uncontaminated soil was processed during the test conducted May 24 to May 29, 1993.

Material processed was excavated from "clean" soils stockpiled at the pretest site. Dust was controlled by spraying the stockpile with water before excavating. Soils were removed from the stockpile and trickled from a 1-m^3 backhoe bucket onto a 150-mm grizzly. Two spray nozzles were mounted at the end of the 25-mm vibrating screen to spray rocks 25 mm to 150 mm to remove fine soil particles. Effluent coming off these sprays was discharged to a nearby trench. Soil particles <25 mm in diameter were conveyed to the trommel where they were separated by a 2-mm wire mesh screen. Particles 2 mm to 25 mm in diameter were sprayed, soaked, and rinsed in the trommel, then stockpiled. Particles <25 mm were sprayed and passed through the screen in the front portion of the trommel, then transferred from the trommel to a second vibrating screen. Both a US #40 (0.425 mm) and US #70 (0.212 mm) screen were tested. Soil fines and slurry passing through the screen were discharged at a rate of about 100 gal/min to a series of cascading water tanks. "Clean" sandy soils (0.425 mm to 2 mm) and fine soils (<0.425 mm) from the test were retained for other potential uses.

The pretest was conducted to prepare the system for Test #1 by making adjustments, repairs, modifications, and screen changes, and to familiarize operators with the system. Random samples were taken to estimate or measure physical properties such as approximate flow rates, percent solids, percent moisture, and degree of separation.

Water used during the pretest was tap water trucked to the site and pumped into two clean plastic holding tanks. Soil piles were flattened out and blended into the surrounding landscape after the pretest was completed.

A more detailed description of the pretest including operation, measurements, and sampling is given in McGuire (1993).

2.2.2 Test #1

This test was conducted in the North Process Pond between June 23 and June 28, 1993. The purpose of this run was to establish the performance of the system. Initial plans were to process 40 tons of soil in this test; however, less material was processed due to unexpected test complications and results explained later in this section.

The screen size selected to separate contaminated and "clean" material was 0.425 mm. Based on data in Tables 1-2, 1-3, and 1-4, this cut point was selected to meet the test goal to reduce the amount of contaminated material by 90% (by weight). The Test #1 system configuration and a material balance for this test are shown in Figure 2-1a. Operating parameters are shown in Figure 2-1b.

Soils processed during this run were excavated from the southwest corner of the North Process Pond near the inlet end of the ponds. Phase I RI characterization data (DOE-RL 1993c) shows that this is the most contaminated portion of the pond. Soils were excavated within 1.0 m of the surface in an attempt to avoid the higher concentrations of uranium, which were characterized by a greenish appearance ("green material"). Based on Dennison et al. (1989) and the RI Phase I report (DOE-RL 1993c), this material was believed to be confined to a thin layer about 1.5 m beneath the ground surface. However, while excavating to a maximum depth of 1.0 m, and after processing the first load of material for Test #1, it was discovered that "green material" was distributed throughout the soils. Thus, for the first day of the test, a decision was made to process the "green material" to determine what system modification, if any, would be needed to meet test performance levels.

On the second day of the test, a new location near the inlet end of the ponds was selected from which to excavate soils. Soils were excavated from nearer to the ground surface in an attempt to avoid the green material. Again, green flakes were found distributed throughout the excavated soils. Some minor system modifications were made with marginal success. As a result, only 2.5 tons of soil was processed the second day. Details are discussed in Section 3.0.

Soils were not processed continuously, as in the pretest, in order to ensure minimal dust exposure. The procedure was as follows. Soils to be processed were wetted down thoroughly prior to excavation. Soils were fed to the grizzly and separated by the 25-mm vibrating screen until the primary hopper was full. After the hopper was full, the conveyor system to the trommel was turned on and the trommel started.

This operating approach (noncontinuous operation and heavy wetting of the soils) resulted in several processing problems including less control in dumping material from the backhoe bucket, clogging of the primary conveyor, and clogging of the trommel slurry line. The approach also contributed to incomplete breakdown of "green" material into discrete fines. The result was that radioactivity levels measured in the field using a Geiger Mueller (GM) detector probe (Eberline Model E-140B) exceeded test performance levels (Table 1-1) in each of the process piles.

Figure 2-1a. System Configuration/Material Balance for Test #1.

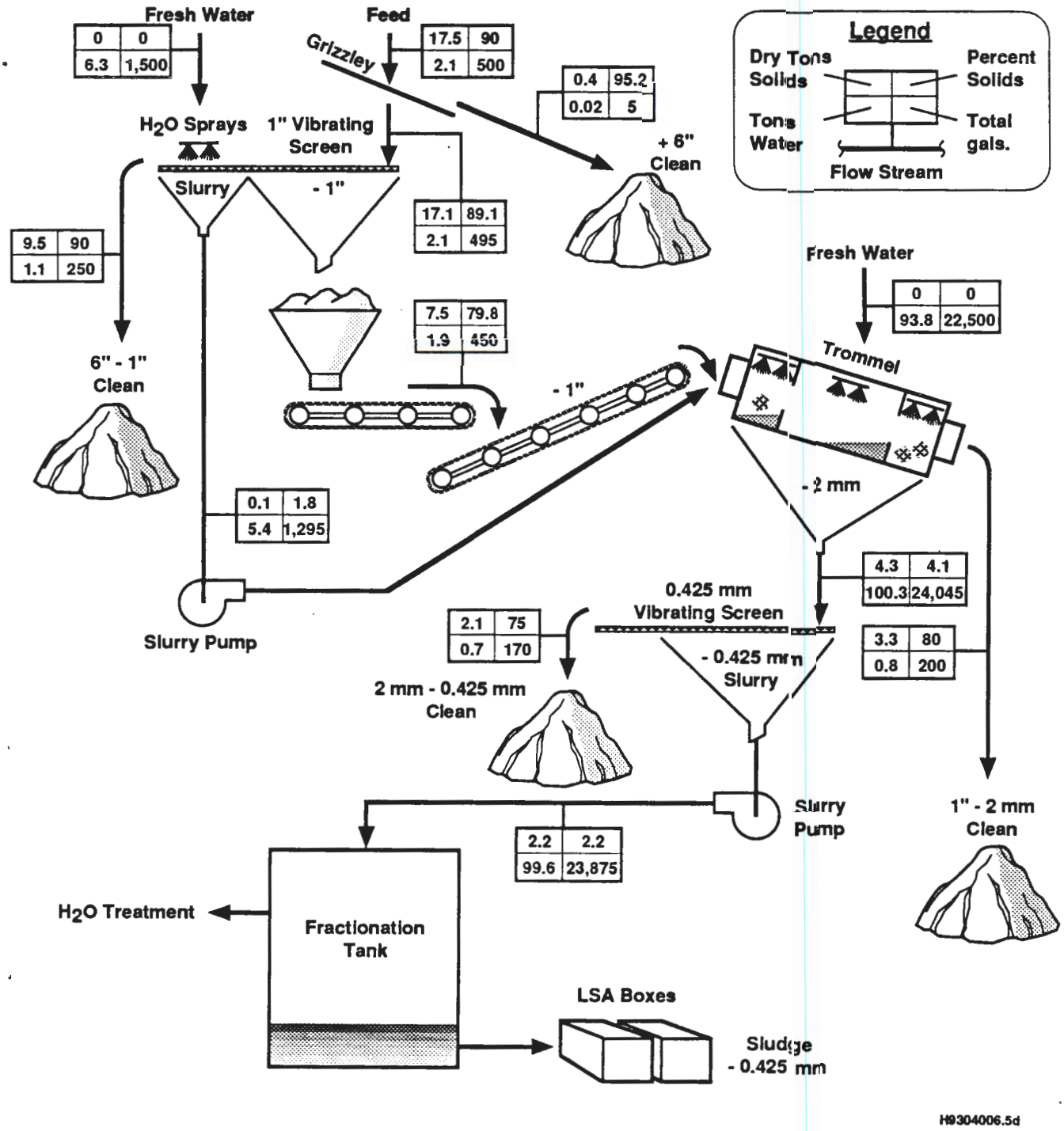

Figure 2-1b. Operating Parameters for Equipment in Test #1.

Primary Screen:	
Area	0.75 by 2.4 m (2.5 by 8 ft)
Size	25.4 mm (1.0 in.)
Slope	0.0 deg
Nozzle Pressure	2.8 kg/cm^2 (40 lb/in^2)
Nozzle Flowrate (total)	38 L/min (10 gal/min)
Trommel:	
Size	1.37-m dia. by 6.4 m (4.5 by 21 ft)
Speed	5.0 rpm
Angle	3.0 deg
Screen Size	2.0 mm (0.08 in.)
Retention Time	3 min.
Initial Rinse:	
Pressure	4.2 kg/cm^2 (60 lb/in^2)
Flowrate (total)	600 L/min (160 gal/min)
Final Rinse:	
Pressure	2.8 kg/cm^2 (40 lb/in^2)
Flowrate (total)	380 L/min (100 gal/min)
Secondary Screen:	
Area	0.56 by 2.1 m (1.8 by 7 ft)
Size	0.425 mm (0.02 in.)
Slope	0.0 deg

In spite of the problems and concerns associated with Test #1, an estimated 17.5 tons of material was processed. Samples of water fed to the system, feed soils, processed soils in each stockpile, and process effluent samples were collected as specified in the test plan. The total number of process soil and effluent samples taken in Test #1 is shown in Table 2-2. Samples were sent to offsite analytical laboratories for chemical and radiochemical analyses and to PNL for chemical and radiochemical screening of soils in each size fraction.

Because offsite laboratories analyzed only total soils in each of the process piles, screening analyses were critical to determining the nature and distribution of the "green material" by size fraction in each of the process piles. In addition to the planned screening analyses, microscopy, X-ray diffraction, and attrition scrubbing, laboratory tests were conducted as part of Test #1 to further characterize the "green material" and better determine what system changes would be required to process soils containing the "green material."

Process water was supplied by water trucks and pumped into two clean plastic tanks with a combined storage capacity of 56,800 L (15,000 gal) to feed the system. After the water cycled through the system, it was stored in two 75,000-L (20,000-gal) fractionation (frac) tanks. The system has no on-line water treatment, so water was not recycled during this run.

As the material was processed through the system, five different process "streams" were created at different points. These streams are listed below.

- >150 mm material overflow from the raw feed grizzly
- 150- to 25-mm material overflow from the primary vibrating screen
- 25- to 2-mm material exiting the trommel
- 2- to 0.425-mm material overflow from the secondary vibrating screen
- <0.425-mm material and process water underflow from the second vibrating screen.

Prior to processing, plastic liners were laid down for each stockpile to ensure that processed material was not mixed with any of the material already in place.

The highest contamination was in the slurry, which was pumped directly to the two frac tanks to be held for water treatment. A third 75,000-L Frac tank remained empty and served as secondary containment.

While water was not treated between the first and second test, the top hatch of the frac tanks was opened to allow water to evaporate; this facilitated additional storage volume for the second test.

Table 2-2. Samples and HEIS numbers for Test #1.

Sample Location	Lab. Analysis Chem. and Rad.	Physical Analysis XRF & Gamma Spec.	TCLP Analysis
Raw Feed	B07C09, B07C10, B07C11, B07C67 (dup to B07C11), B07C38, B07C39, B07C40	B08MN6, B08NM2	
Plus 150 mm		B08MN8*, B08NM4*	
150 to 25 mm		B08MN9, B08NM5	
25 mm to 2mm	B07C14, B07C15, B07C16, B07C17, B07C18, B07C19, B07C20, B07C21, B07C22, B07C23, B07C24, B07C25, B07C43, B07C44, B07C45, B07C46	B08MP0, B08NM6, B08NM8	
2mm to 0.425mm	B07C26, B07C27, B07C28, B07C29, B07C30, B07C31, B07C32, B07C68 (dup to B07C31), B07C55, B07C56, B07C57, B07C58	B08MP1, B08NM7, B08NM9	
Minus 0.425mm Slurry Water	B07C75, B07C76, B07C77, B07C85 (dup to B07C76), B07C79, B07C80, B07C81		
Minus 0.425mm Slurry Soils	B07C91, B07C92, B07C93, B07C95, B07C96, B07C97, B07CB1 (dup to B07C97),	B08MN7, B08NM3	B08MN0, B08NL6
Fresh Water	B07C70, B07C73 (trip blank), B08MM8, B07C71, B07C72 (dup to B07C71), B08NL4		
Trip Blanks	B07C74, B07C87, B07CB2, B07CB3		

* Analysis of only fine soils washed off the rocks. 150-mm material was not analyzed.

2.2.3 Test #2

The purpose of this test was to provide a final run to show the effectiveness of system modifications implemented as a result of findings from Test #1.

Contingent on the results of Test #1, it was originally planned (DOE-RL 1993b) to process similar material and use a smaller screen size in Test #2 (US #70 versus US #40) to determine whether smaller soil particles could be separated to meet test performance levels. Test #2 would also help to determine what the optimal cut point for physical separations may be.

However, radioactivity was found in all of the process piles in Test #1. As a result, Test #2 was not performed until analytical data from Test #1 had been received and evaluated. In Test #2, soils were processed that did not contain the "green material," and the larger US #40 screen size was used.

These changes were made because the data indicated that additional equipment, not available for Test #2, was needed in the system to scrub and break down soils containing the "green material." It was believed that the system used for Test #1 could process soils that did not contain the "green material," but a test was needed to prove this concept.

Prior to conducting Test #2, field radiological measurements were made using a GM to identify those locations in the ponds with and without the "green material" and to measure the radioactivity levels of soils. Green material was found in soil piles along the west side of the North Process Pond, with radioactivity levels ranging from 150 dpm to 1200 dpm above background readings (500 dpm). No "green material" was observed on the north-central end and along the east side of the North Process Pond, and the radioactivity of soils was measured at near background levels (500 dpm). Based on RI Phase I investigations (DOE-RL 1993c), the soils with radioactivity near background levels comprise about 75% of the pond area being investigated for remediation.

While field measurements showed low radioactivity levels in soils not containing the "green material," laboratory analyses typically detect significantly lower levels of radioactivity than field GM probe measurements and would therefore show contaminant levels in each fraction of processed soils. Therefore, although radioactivity levels were low and RI Phase I data show that contaminant levels would be below test performance levels (see Table 1-1), low-activity soils were processed to determine if, or by how much, the concentration of contaminants in the larger soil fraction could be reduced using physical separation methods.

Test #2 was conducted September 8 and 9, 1993. An estimated 15 tons of soil, collected from three different areas of the pond (see Figure 1-2), was processed on September 8.

A US #40 sieve was used for this test because soils processed in Test #1 using the US #40 sieve did not meet test goals; therefore, use of a smaller sieve for Test #2 would likely have been counter-productive.

Excavation and dust control were performed as in Test #1. The system was modified, however, so a small front-end loader could be used to feed the system. Modifications involved mounting the 150-mm grizzly on a shorter, smaller hopper and adding a conveyor to move soils from this hopper to the 25-mm screen (Figure 2-2a). With these modifications, less water was required for dust control and the system operated continuously.

The system configuration and a mass balance for Test #2 are shown in Figure 2-2a. Operating parameters are shown in Figure 2-2b. The sample scheme used for Test #2 was the same as for Test #1. Process soil and effluent samples taken in Test #2 are shown in Table 2-3.

A secondary objective of Test #2 was to process additional soils containing "green material" to see if equipment adjustments could be made to process the soils successfully without adding an attrition scrubber. Changes were made to the trommel angle and speed to increase retention time and energy input. Sprays were added to the 0.425-mm screen, and the speed of the screen vibration was reduced to enhance particle separation. During this phase of Test #2, radioactive levels of processed soil fractions were measured in the field using a GM, but no samples were taken to send to the laboratory because radioactivity was still found in soil fractions intended to be "clean."

2.2.4 Water Treatment

Water treatment tests were conducted following completion of Test #2. Because laboratory tests had indicated that contaminants did not solubilize in the process effluent (Gerber et al. 1991), water treatment was a secondary objective of these tests. Optimal water treatment methods were not investigated because tests indicated that filtration and addition of flocculents to enhance flocculation may be sufficient. The primary goal of water treatment tests was to separate fine soils from the effluent and to treat effluent in the frac tanks to meet purgewater acceptance standards (Appendix A).

Initial tests were conducted using a skid-mounted clarifier that was obtained from the EPA and renovated for the test. Renovations included replacing pumps, adding pressure and water flow gages, and plumbing. Chemical engineers selected a flocculent to enhance particle settling and ferric chloride to coagulate particles in solution.

In addition to the clarifier, a skid-mounted ion exchange unit was assembled for groundwater treatment applications and was made available to treat the process effluent if needed. A schematic of the clarifier and ion exchange system is shown in Figure 2-3.

Figure 2-2a. System Configuration/Material Balance for Test #2.

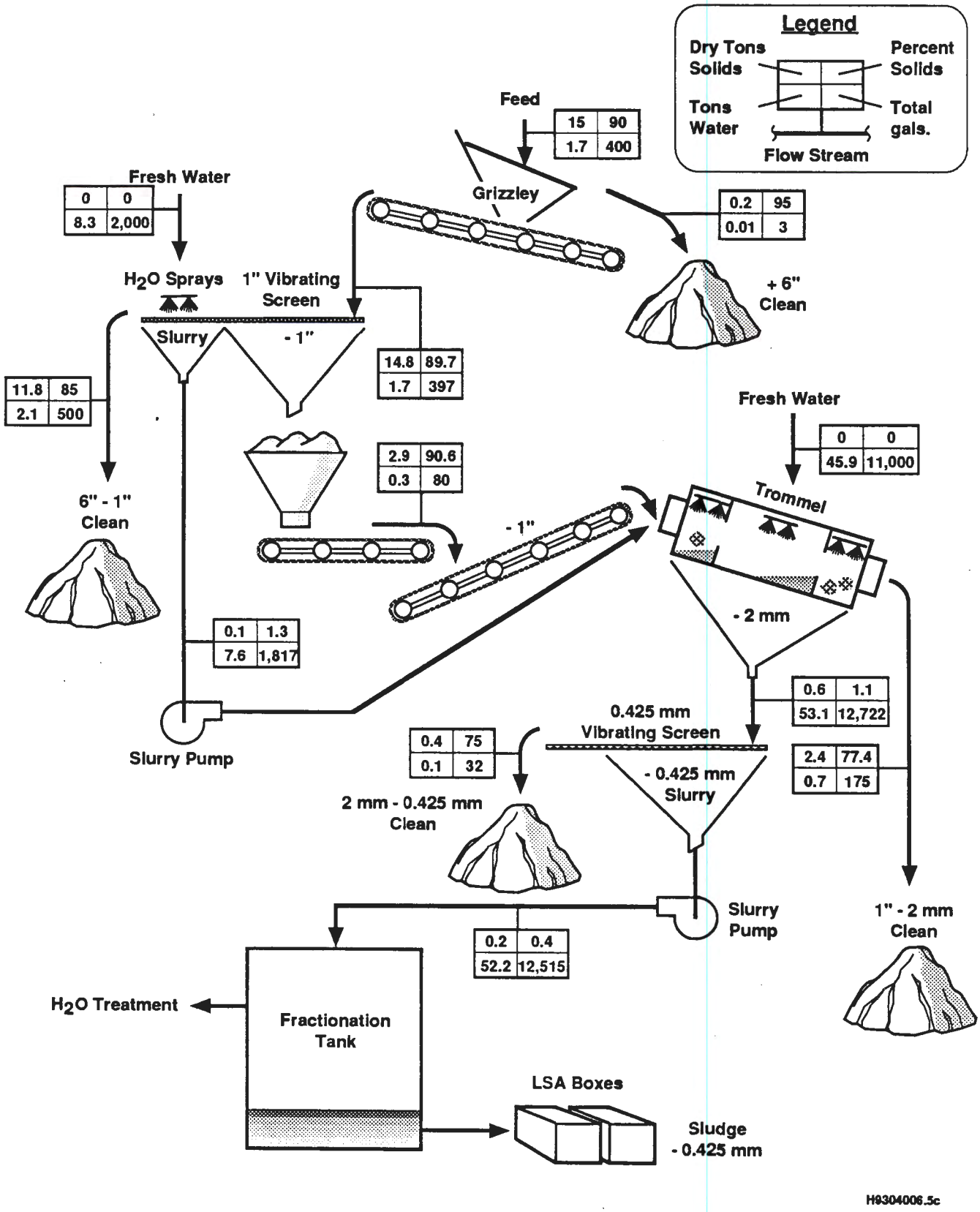

Figure 2-2b. Operating Parameters for Equipment in Test #2.

	Run #1	Run #2 (Green Material)
Primary Screen:		
Area	0.75 by 2.4 m (2.5 by 8 ft)	
Size	25.4 mm (1.0 in.)	
Slope	0.0 deg	1.5 deg
Nozzle Pressure	2.8 kg/cm^2 (40 lb/in^2)	
Nozzle Flowrate (total)	38 L/min (10 gal/min)	
Trommel:		
Size	1.37-m dia. by 6.4 m (4.5 by 21 ft)	
Speed	5.0 rpm	7.0 rpm
Angle	3.0 deg	0.0 deg
Screen Size	2.0 mm (0.08 in.)	
Retention Time	3 min.	20 min.
Initial Rinse:		
Pressure	4.2 kg/cm^2 (60 lb/in^2)	
Flowrate (total)	600 L/min (160 gal/min)	
Final Rinse:		
Pressure	2.8 kg/cm^2 (40 lb/in^2)	
Flowrate (total)	380 L/min (100 gal/min)	265 L/min
Secondary Screen:		
Area	0.56 by 2.1 m (1.8 by 7 ft)	
Size	0.425 mm (0.02 in.)	
Slope	0.0 deg	-0.50 deg

Table 2-3. Samples and HEIS numbers for Test #2.

Sample Location	Lab. Analysis Chem. and Rad.	Physical Analysis XRF & Gamma Spec.	TCLP Analysis
Raw Feed	B07DP9, B07DQ0, B07DQ1, B07DQ2, B07DQ3	B09758	
Plus 150 mm			
150 to 25 mm		B09761*	
25 to 2mm	B07DV2, B07DV3, B07DV4, B07DV5, B07DV6, B07DV7, B07DV8, B07DV9, B07DW0, B07DW1, B07DW2, B07DW3	B09762	
2mm to 0.425mm	B07DW4, B07DW5, B07DW6, B07DW7, B07DW8, B07DW9, B07DX0, B07DX1, B07DX2, B07DX3, B07DX4, B07DX5	B09763	
Minus 0.425mm Slurry Water	B07DT2 (UF), B07DT3 (F), B07DT4 (UF), B07DT5 (F), B07DT6 (UF), B07DT7 (F), B07DT8 (UF), B07DV0 (UF)	B09760	
Minus 0.425mm Slurry Soils	B07DS7, B07DS8, B07DS9	B09759	B09757 (split to B07DS9)
Fresh Water	B07DQ4, B07DX8 (dup to B07DQ4), B07DQ5, B07DX9 (dup to B07DQ5)		
Trip Blanks	B07DY5, B07DY6 B07DY0, B07DY1		

* Analysis of only fine soils washed off the rocks. 150-mm material was not analyzed.

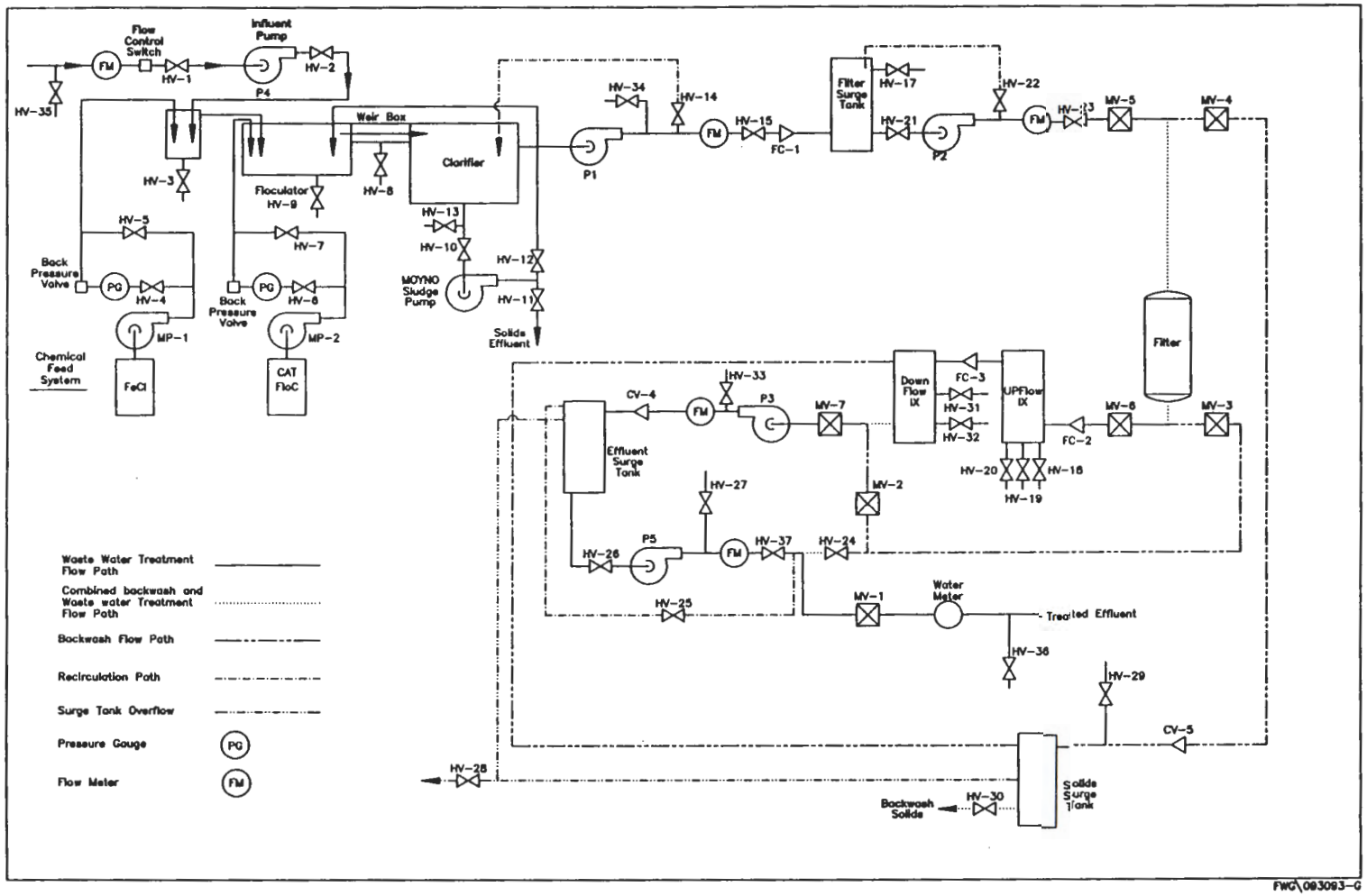

Figure 2-3. Schematic of the Water Treatment System.

In spite of previous laboratory indications to the contrary, in Test #1 much of the uranium (likely the "green material") solubilized in the process effluent (Section 3.4). Therefore, the goal of the test was not only to filter effluent to remove contaminated solids from the frac tanks, but also to remove soluble uranium from the effluent. It was expected that several cycles from the frac tanks through the water treatment system would be required to treat the effluent to acceptable standards (Appendix A).

The frac tanks contained approximately 38,000 gal of effluent from Test #1 and Test #2, of which approximately half of the water was processed in a single cycle through the clarifier skid. Field screening results are discussed in Section 3.4.

Water treatment tests were not completed because delays resulted in testing in cold weather conditions. By the second week of November it was determined by field operators and engineers that modifications were required for the ferric chloride and flocculents to work effectively in the cold weather. In addition, in order to protect the environment from potential leaks that may have otherwise been caused by freezing of the system during operation, operations were terminated before Thanksgiving and are not expected to resume until spring at the earliest.

During water treatment tests, two sets of samples were collected on days when the system appeared to be operating properly as determined by the field supervisor: one about midmorning and another at midafternoon. Samples were collected before and after treatment and screened by PNL using inductively coupled plasma/mass spectrometry (ICP/MS) analytical methods. In addition, a sample screening trailer was set up in the field to analyze the soils for chromium content using a Hach Kit (a Trademark of Hach Company), and to determine the turbidity of effluent before and after treatment.

Samples were to be collected and sent offsite for radiochemical and chemical analyses as specified in the test plan (DOE-RL 1993b); however, the field supervisor and operating engineers determined that this should not be done until after a full day of effective operations as indicated by field screening results.

Due to cold weather conditions, operating problems with the pump used to inject ferric chloride into the system, and the lack of solids from the frac tanks in the early stages of processing, two consecutive days of operation were not realized.

Results of field screening and PNL screening analyses during the early stages of water treatment tests are included in Section 3.4. These were strictly EPA analytical level one field screening tests.

2.3 EQUIPMENT AND MATERIALS

The following equipment was required for the tests:

- Soil-Washing System
  - one 1-m^3 Hopper (from EPA) modified to include 150-mm grizzly
  - one 5-m^3 Hopper and feed conveyor
  - two belt conveyors (one from EPA)
  - 25-mm vibrating screen
  - Kinergy shaker (from EPA)
  - two #40 (0.425-mm) and two #60 (0.210-mm) screens
  - 1.37-m diam. X 6.4-m long trailer-mounted trommel (from EPA)
  - Generator (from EPA)
  - three 75,700 L frac tanks
- Two plastic water tanks 24,600 L, and 34,000 L (from EPA)
- one 6-kW gasoline pump
- Miscellaneous hoses and connections
- Water truck
- Backhoe
- Front-end loader
- Field/Handheld radiation monitoring instruments
- Anti-Contamination Clothing (Anti-C's)
- Miscellaneous tools
- Sampling containers and equipment
- Change trailer
- Dust monitoring Instruments
- Wind and temperature gages
- First Aid/safety equipment
- Radios/cellular phone
- Logbook

2.4 SAMPLING AND ANALYSIS

The following sampling and analysis scheme applied to both Test #1 and Test #2.

EPA analytical level III and level V analyses (EPA 1990) were performed by offsite laboratories in accordance with the test plan. Samples were analyzed for metals using EPA methods (EPA 1990), for total uranium using fluorimetry, and for radionuclides using gamma spectroscopy. Water samples were analyzed for these constituents and volatile organic compounds using EPA methods (EPA 1990). The field measurements for pH and temperature were taken from a separate bottle.

All samples receiving Level III chemical analysis and Level V radiochemical analysis were validated.

Using Level A procedures, 90% of the data were validated (WHC 1990). Level A is the minimum requirement for data.

Review requirements for Level A are as follows:

- requested versus reported analyses
- analyses holding times.

Ten percent of the data were validated using WHC Level B RCRA data validation procedures. Level B provides a more in-depth review of data for programs where data is compiled for use in reports.

Review requirements in addition to those listed for level A:

- matrix spike/matrix spike duplicate analysis
- surrogate recoveries
- duplicate analysis
- analytical blank analysis.

In addition, samples were sent to PNL for screening analyses (EPA Level 1). The purpose of the screening was for PNL to sieve and analyze samples by size fraction at a lower cost and with faster turnaround times than could be obtained by first sieving the samples and then obtaining similar analyses of each of the size fractions from the analytical laboratories.

Soil samples sent to PNL were wet sieved and then dried. Each size fraction was analyzed for metals using x-ray fluorescence (XRF) and for radionuclides using gamma spectrometry. The following sieve sizes (mm) were used: 25, 13.2, 9.5, 2, 1, 0.425, 0.212, 0.150, and 0.075. Laboratory sieves smaller than 0.425 mm were used in order to determine if soils smaller than 0.425 mm could be separated to meet test performance levels. Additional discussion of PNL analyses is included in Serne et al. (1993).

2.4.1 Pre-Process Samples

Prior to processing, a clean process water sample was taken from clean water holding tanks. This sample received chemical and radiochemical analysis. It was also tested for temperature and pH using EPA Level I analytical methods.

2.4.2 Process Samples

During processing, the feed material stream and the final process slurry stream were sampled. The first effluent sampling event occurred after the material appeared at the sampling point described in this section. The final sample was collected just prior to completion of the processing. Process soil and effluent samples taken included the raw feed soils, slurry water, and slurry soils shown in Tables 2-2 and 2-3.

The following samples were taken:

- 500-mL samples of the feed soils were sent offsite to Data-Chem/IT laboratories for chemical and radiochemical analysis.

- 3,500-mL samples of the feed soils were sent to PNL for analytical screening. A sub-sample was composited, weighed, dried, and weighed again to determine moisture content. The remaining sample was wet sieved. Individual size fractions were analyzed using XRF and gamma spectrometry.

- 3,500-mL samples of the process effluent with suspended solids were sent offsite to Data-Chem/IT laboratories. Samples were taken at a minimum after every hour of continuous processing throughout the processing period. Effluent samples for Test #1 were not filtered. In Test #2, effluent samples were filtered in the field prior to being sent to the laboratory for analysis. Solids in the effluent were analyzed separately for both tests.

- 3,500-mL samples of the process effluent with suspended solids were sent to PNL for analytical screening. Solids from the composite were wet sieved, and each fraction was weighed. Individual fractions were mixed with size separates from the other soil piles in order to provide enough material for adequate analysis and to reduce the amount of analyses that were required. Each of these fractions was analyzed using XRF and gamma spectrometry. Filtered effluent was analyzed by ICP and by ICP/MS to get measurements of major cations.

- 2,000-mL samples of the process effluent and suspended solids were sent to an offsite laboratory for toxic characteristic leach procedure (TCLP) analysis of the extract from fine soil particles. These samples were handled by Hanford Analytical Systems Management (HASM). Solids were filtered out of the effluent to conduct the TCLP analysis.

2.4.3 Post Process Samples

Random samples were taken from each process pile at the completion of processing. This is described in the following paragraphs. Post-process samples taken are shown in Tables 2-2 and 2-3.

2.4.3.1 >150-mm Material. The pile was measured to estimate the volume of material. Then the pile was surveyed for total activity using a GM probe. One 22-L (5-gal) sample for Test #1 and one for test #2 was sent to PNL where fine soils were rinsed off the rock. The rocks and soils were then dried and weighed to show the size distribution of soils and rocks screened by the 150-mm grizzly.

2.4.3.2 150- to 25-mm Material. The pile was measured to estimate the volume of material. Then the pile was surveyed for total activity using a handheld instrument. Samples were sent to PNL for analysis. The samples were composited to make up 22 L (5 gal) of material. The composited material was weighed and wet sieved. Each fraction was then dried, weighed, and mixed with similar sized material from other process piles. Analyses were conducted using XRF (9.5 mm and smaller) and gamma spectrometry.

2.4.3.3 25- to 2-mm Material. The pile was measured to estimate the volume of material. Then the pile was surveyed for total activity using a GM probe. Two 300-mL samples were taken from each of 16 locations. One sample from each location was sent to PNL for analytical screening. Samples were composited, weighed, and wet sieved. Each fraction was then dried, weighed, and mixed with similar sized material from other process piles. Analyses were conducted using XRF (9.5 mm and smaller) and gamma spectrometry.

The other 16 samples were sent to the analytical laboratory for chemical and radiochemical analysis.

2.4.3.4 2- to 0.425-mm Material. The pile was measured to estimate the volume of material. Then the pile was surveyed for total activity using a GM probe. Two 300-mL samples were taken from each of 16 locations. One sample from each location was sent to PNL for analytical screening. Samples were composited and weighed and wet sieved. Each fraction was then dried, weighed, and mixed with similar sized material from other process piles. Analyses were conducted using XRF (9.5 mm and smaller) and gamma spectrometry.

The other 16 samples were sent to the analytical laboratory for chemical and radiochemical analysis.

2.4.3.5 <0.425-mm Material. All samples of this material were taken during processing (see Section 2.4.2, Processing Samples).

2.5 RESIDUALS MANAGEMENT

The process effluent and associated fines were collected in three 75,000-L frac tanks. There was no on-line water treatment. After soil-washing tests were completed, process water treatment began. Initial water treatment consisted of settling and removal of fine soils using ferric chloride and another polymer in a clarifier to flocculate particles and enhance settling. Sand filters and ion exchange columns were available if precipitation alone was not sufficient to meet purgewater acceptance standards. Effluent was treated at a rate of 40 gal/min.

Process effluent was recycled through the treatment system and back into the frac tanks until solids were removed from the frac tanks and effluent met purgewater acceptance standards (Appendix A). This work was interrupted by cold weather and will resume in the spring of 1994.

The solids removed from the effluent were contained in low specific activity (LSA) boxes. The LSA boxes will remain in the bottom of the North Process Pond until final remediation begins, when they will be disposed of with the other 300-FF-1 OU wastes in accordance with a Record of Decision (ROD) when it is completed.

2.6 DATA MANAGEMENT

All data collected during this study was managed in accordance with WHC Environmental Investigation Instructions (WHC 1988) and the 300-FF-1 Data Management Plan (Attachment 4, DOE-RL 1990).

Samples were assigned a Hanford Environmental Information System (HEIS) computer code number, and information associated with the samples will be entered into HEIS. Copies of data obtained were forwarded to the Environmental Data Management Center to be placed in the administrative record and/or project records, as applicable.

A field logbook was maintained recording test times, personnel participating, pre-job safety and tailgate meetings, and occurrences during tests. The logbook, currently in use to record water treatment field activities, will be issued and entered into the administrative record upon completion.

2.7 QUALITY ASSURANCE/QUALITY CONTROL

Analytical samples were subject to in-process quality control (QC) measures specified in the *Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit* (DOE-RL 1990) in both the field and laboratory. QA samples for tests included duplicates for each size fraction and trip blanks shown in Tables 2-2 and 2-3 and in Appendix B.

Ten percent of the samples receiving Level III chemical analysis and Level V radiochemical analysis were validated using WHC Level B *Resource Conservation and Recovery Act* (RCRA) data validation procedures. The other 90% were validated using Level A procedures. These requirements are specified in Section 5.0 of the test plan (DOE-RL 1993b).

Analytical methods, parameters, detection limits, and precision and accuracy requirements for data presented in Appendix B were consistent with specifications in Table A-1 of the test plan (DOE-RL 1993b).

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3.0 RESULTS AND DISCUSSION

3.1 PRETEST RESULTS

Detailed discussion and results of the pretest are included in McGuire (1993). In general, the objectives of the pretest were met. Operators gained experience operating the soil-washing system, system repairs were made, and the system was readied for the test.

Approximately 35 tons of soil was processed through the system. Both a US #40 (0.425-mm) and US #70 (0.212-mm) sieve were tested. Modifications were made to reduce water splash and enhance dust control. Soils were separated such that dry sieving in the laboratory indicated 96% by weight of 25-mm to 0.212-mm fraction of soils was greater than 0.300 mm. Based on this processing, equipment settings were selected to achieve the best size separation at an acceptable throughput rate.

An added benefit of the pretest was the opportunity for close observation by WHC and RL management of the system in operation. This was not done during Test #1 and Test #2 because these tests were conducted in a surface contamination area (SCA) where the closest observation point was over 50 m from the system.

3.2 TEST #1 RESULTS

The following is a description and summary of data analyses obtained as part of Test #1. Data analyses are included in Appendix B.1 and the PNL sediment characterization report (Serne et al. 1993).

Samples and HEIS numbers of samples collected during Test #1 were discussed in Section 2 and shown in Table 2-2.

3.2.1 Analysis of Waste Stream

A summary of physical characteristics of the feed soils processed in Test #1 is shown in Table 3-1 and Figure 3-1a. Figure 3-1b shows the percent of the total processed material reporting to each process pile. The soils were located near the pond inlet and within 0.5 m of the ground surface. Therefore, they contain more fine particles than anticipated based on the RI Phase I studies and previous characterization of soils conducted by PNL (Serne et al. 1992). However, as shown in Figure 3-1a, a 90% reduction by weight could still be achieved if soils are successfully separated with particles larger than 0.212 mm meeting established performance levels.

Soils processed on the second day of operation contained higher uranium concentrations than those processed the first day. The average concentration and standard deviation for chemical and radiochemical contaminants in feed soils processed on both days, as obtained by IT/Data Chem analytical laboratories for soils <2 mm are shown in Table 3-2. These data show that prior to processing, only uranium concentrations were greater than the

Table 3-1. Wet-Sieved Size Distribution of Feed Soils in Test #1 (Percent by weight). (Serne et al. 1993)

Size Fraction	Run #1	Run #2	Average
>25 mm	60.5%	51.2%	55.9%
2 mm to 25 mm	14.3%	25.5%	19.9%
0.425 mm to 2 mm	12.3%	11.7%	12.0%
0.212 to 0.425 mm	5.81%	5.32%	5.57%
0.150 to 0.212 mm	1.26%	1.16%	1.21%
0.075 to 0.150	2.30%	2.00%	2.15%
<0.075	3.49%	3.06%	3.28%

performance levels for contaminants specified in the test plan (see Table 1-1). PCBs were not analyzed for in Test #1 due to miscommunication with the analytical laboratories. However, PCBs were analyzed for in Test #2.

Green and white colored soils were separated (based on appearance) in the laboratory from unused portions of Test #1 feed soil samples sent to PNL. Table 3-3 shows that the 1-mm to 9.5-mm white colored soils were made up primarily of aluminum and silicate and were not generally radioactive. The same sizes of green material contained lower concentrations of aluminum than the white material and higher concentrations of calcium, copper, zirconium, and uranium. A more detailed analyses of the "green material" is given in Serne et al. (1993).

3.2.2 Analysis of Processed Soils

On the first day of the test (June 23, 1993), 10 tons of excavated soil was processed. The soils contained green material with elevated concentrations of uranium/copper embedded in calcium carbonate. Field measurements using a GM probe showed that feed soils contained up to 15,000 dpm above background (500 dpm). After processing, soils from 0.425 mm to 25 mm still showed elevated counts (Table 3-4).

Figure 3-1a. Average Wet-Sieved Size Distribution of Feed Soils in Test #1 (Percent by Weight) (Serne et al. 1993).

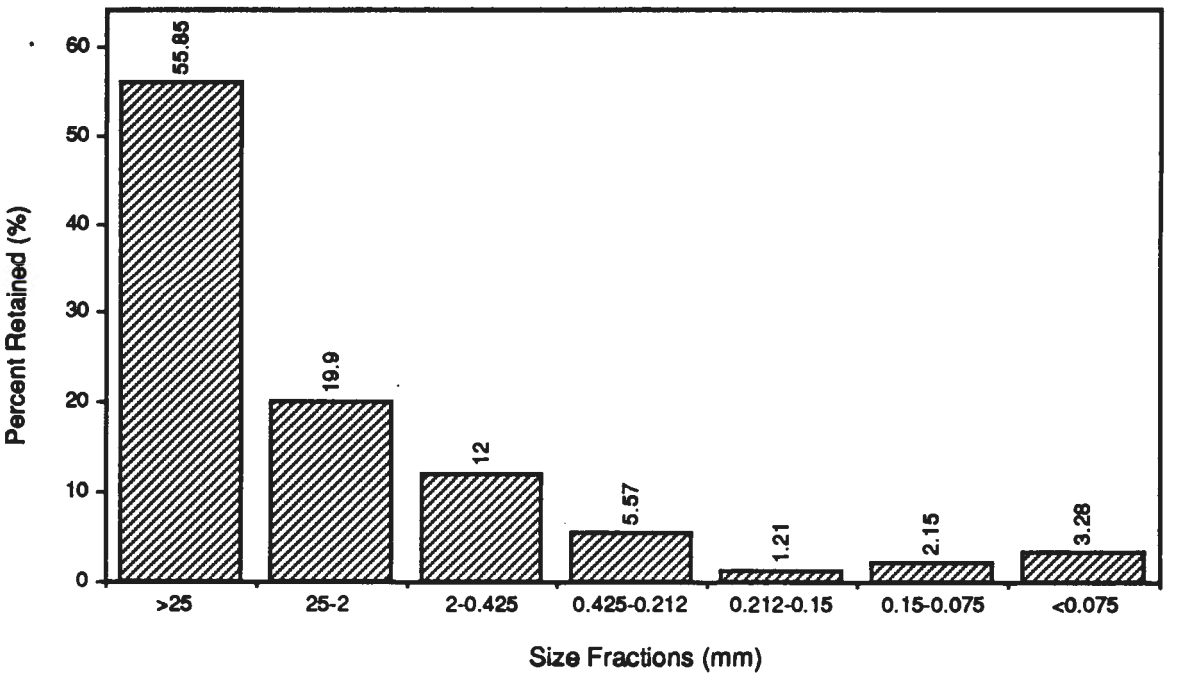

Figure 3-1b. Percent of Soils in Each Process Pile, Test #1 (Percent by Weight).

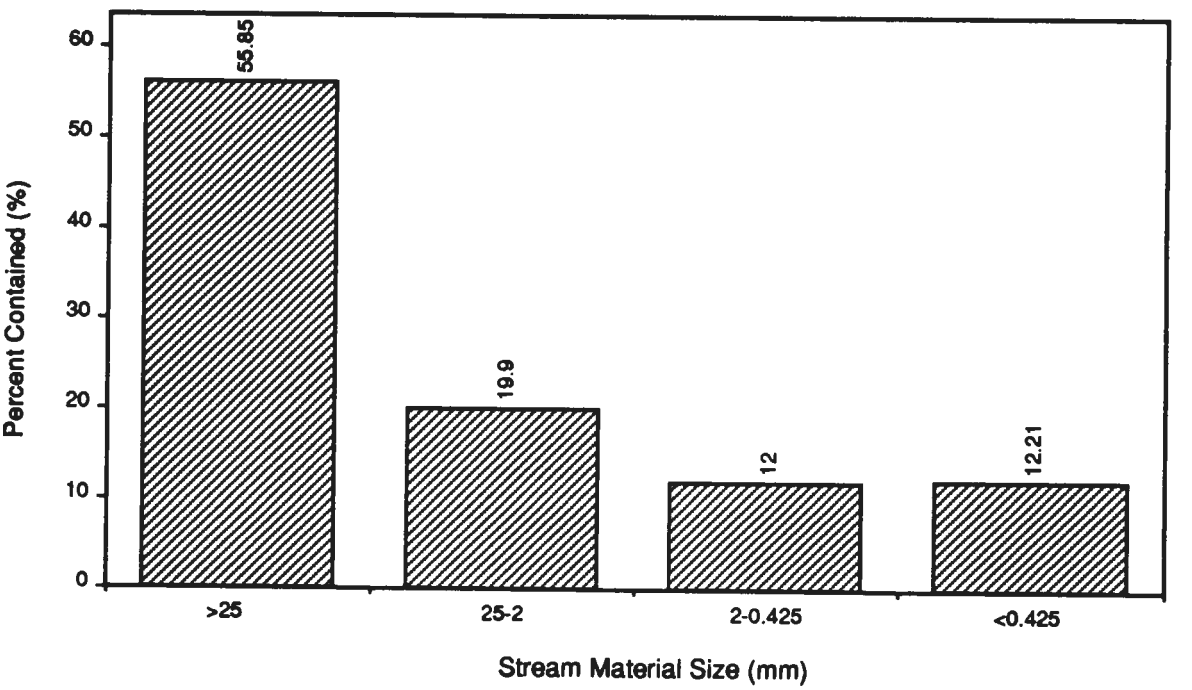

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Table 3-2. Chemical and Radiochemical Analyses of Feed Soils <25 mm[1] and Feed Water for Test #1 (Appendix B.1).

	Feed Soils		Feed Water	
Constituent	Avg	S	Avg	S
	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Co-60	0.0	0.0	6.42	3.31
Cs-137	0.2	0.1	2.44	1.84
Pb-212	1.4	0.4	0	0
Pb-214	0.5	0.1	0	0
Ra-224[2]	0.6	0.3	0	0
Ra-226[2]	1.3	0.5	0	0
Ru-106[2]	0.0	0.2	6.31	7.57
Sb-125[2]	0.0	0.1	0.0	0.0
U-Nat	1802	923	0.60	0.41
	(mg/kg)	(mg/kg)	(mg/l)	(mg/l)
Ag	21.0	20.2	0	0
Al	22571	3923	0.15	0.076
As	2.2	0.7	0	0
Ba[2]	1062.9	522	0.026	0
Be	0.5	0.5	0	0
Ca[2]	11086	26702	18	1.41
Cd	0.4	0.5	0	0
Co[2]	6.9	0.4	0	0
Cr	224.3	132	0	0
Cu	2763	3123	0.007	0.003
Fe	16857	1355	0.42	0.031
Hg	2.3	0.6	0	0
K[2]	1046	250	0.92	0.43
Mg	6386	766	4.2	0.309
Mn	253	10.3	0.012	0.001
Na[2]	2043	592	2.8	0.28
Ni	278	289	0	0
Pb	47.9	17.1	0.005	0.003
Sb	5.9	4.3	0	0
Sn[2]	21.3	12.6	0	0
V[2]	37.1	3.3	0.001	0.002
Zn	86.7	28.2	0.005	0.003
(Water Only)				
Chloroform[2]	NA	NA	0.02	
Methyl Ethyl Ketone	NA	NA	U	0.0
Tetrachloroethylene	NA	NA	U	0.0
Tetrahydrofuran[2]	NA	NA	U	0.0
Trichloroethylene	NA	NA	U	0.0
1,2-Dichloroethylene, d4	NA	NA	0.05	0.0
Toluene, d8[2]	NA	NA	0.05	0.0
4-Bromofluorobenzene[2]	NA	NA	0.05	0.0

S = Standard Deviation
U = Undetected
NA = Not Analyzed

1. Note - material > 25 mm are not able to be handled by the laboratory. Material between 25 mm and 2 mm was crushed to 2 mm or less and then analyzed.

2. Constituents analyzed in the laboratory for information, but not identified in Table 1.1.

Table 3-3. Composition of Green and White Sediment in the 300-FF-1 North Pond (Weight Percent). (Serne et al. 1993)

Elements[1]	Green (1-2 mm)	Green (2-9.5 m)	White (1 to 2 mm)	White (2 to 9.5 mm)
Na_2	0.31	1.21	1.12	0.71
MgO	3.04	4.19	0.70	0.12
Al_2O_3	31.21	24.80	50.59	56.94
SiO_2	7.71	20.43	12.00	5.41
K_2O	0.16	0.33	0.18	0.06
CaO	7.50	9.00	2.49	1.28
TiO_2	0.05	0.14	0.05	0.02
Cr_2O_3	0.16	0.25	0.02	0.00
MnO_2	0.06	0.06	0.01	0.00
Fe_2O_3	0.57	2.33	0.33	0.12
NiO	0.28	0.36	0.02	0.00
CuO	7.68	4.99	0.16	0.03
ZnO	0.03	0.05	0.01	0.00
SrO	0.03	0.04	0.02	0.00
PbO	0.03	0.04	0.01	0.00
ZrO_2	1.72	2.62	0.06	0.01
Ag_2O	0.02	0.03	0.00	0.00
SnO_2	0.05	0.05	0.01	0.00
BaO	0.03	0.05	0.02	0.00
UO_2	1.97	1.89	0.18	0.08
Ce_2O_3	0.0	0.02	0.00	0.00
LOI @ 900 °C	37.42	25.92	32.02	33.22

1. The percent concentration of elements in the sediment are given as oxides such that columns add to 100%. However, the elements were not in the form of oxides.

2. LOI is loss on ignition to 900°C of carbonate and bound waters.

Table 3-4. GM Probe Field Radioactivity Measurements after Processing.

Size Fraction	Radioactivity (dpm/100 cm^2 above background*)
2 mm - 25 mm	1,500 to 6,750
0.425 mm - 2 mm	6,500 to 12,000

* Background about 500 dpm

It was determined after discussions with DOE-RL, EPA, and Ecology that a second run would also be made using the 0.425 mm and relocating the excavation site to avoid the "green material."

On June 24, 1993, an additional 2.5 tons was processed. While soils were excavated from closer to the ground surface and in an area that appeared to be undisturbed, soils still contained flakes of the "green material," and the radioactivity level of feed soils was higher than the previous day (up to 35,000 dpm). After processing, elevated activity levels were measured in each size fraction in the same ranges as those shown in Table 3-5.

A third and final run for Test #1 was made on June 25, 1993, in which about 0.5 tons of soil was processed to clean out the hopper and trommel. Prior to processing, the trommel angle was lowered to 0° to increase the retention time. In this run, the "green material" was broken up more in the trommel than in previous runs, but a few flakes remained in the 25-mm to 2-mm fraction and the 2-mm to 0.425-mm fraction contained radioactivity in the range shown in Table 3-4. Samples from this run were collected, and particle size analyses were performed by PNL. No other analyses were performed for this run.

A closer look at material in each of the size fractions showed that the activity was associated with the "green material" in the form of balls or flakes that did not break down in the soil-washing system. However, the material did crumble to a very fine particle size when a slight amount of pressure was applied, indicating that the trommel and screen system used for Test #1 may not provide enough energy directly to the particles.

In the 2-mm to 25-mm fraction, it was possible to visually identify and physically separate the "green material." When this was done in the field, the resulting gravels showed radioactivity levels below background levels (500 dpm) and the green material was in the ranges shown in Table 3-4.

Soil and effluent samples were collected and sent for analyses to assess which contaminants were in each of the fractions and to determine what water treatment would be required to meet purgewater acceptance standards. A summary of laboratory analyses is shown in Table 3-5. Additional data is included in Appendix B.1.

Data in Table 3-5 show that all the constituents in all the soil piles were below the performance limits for the test except uranium. This was also true of the feed soils prior to processing (see Table 3-2). As expected, based on field measurements, uranium levels exceeded test performance limits in all of the process piles. TCLP analyses (Appendix B.1) showed that all volatile organics, semi-volatile organics, chlorinated pesticides, chlorinated herbicides, and metals analyzed for were significantly below regulatory TCLP limits.

Unfiltered laboratory analyses of process effluent show significant uranium concentrations (see Table 3-5). IT/Data Chem analytical laboratories did not provide data for filtered samples. Process effluent samples were filtered using a 0.045-μm filter and analyzed by PNL (Table 3-6).

Table 3-5. Test #1 Screening Analyses for Each of the Process Piles and Unfiltered Effluent. (Serne et al. 1993)

Constituent	25-2 avg	2-0.425 avg	< 0.425 avg	Unfilt. Effluent (avg)
	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/l)
Co-60	0.02	0.03	0.01	3.36
Cs-137	0.06	0.10	0.20	7.69
U-Nat	791	650	329	39886
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/l)
Ag	4.39	11.1	1.3	0.53
Al	11694	16000	8214	562
As	0.92	1.44	1.4	0.02
Be	0.11	0.04	0.1	0.01
Cd	0.07	0.08	0.0	0.0
Cr	62.5	122	39.1	5.77
Cu	1318	2025	330	52.2
Fe	17275	17333	14571	155
Hg	0.54	1.18	0.2	0.09
Mn	225	241	184	3.52
Ni	104	176	32.7	4.99
Pb	17.6	32.83	15.6	1.36
Sb	0.45	0.93	0.7	0.0
Zn	51.2	64.25	39.6	1.74
(Water Only)				
Chloroform	NA	NA	NA	0.01
Methyl Ethyl Ketone*	NA	NA	NA	0.05
Tetrachloroethylene	NA	NA	NA	0.002
Tetrahydrofuran*	NA	NA	NA	U
Trichloroethylene	NA	NA	NA	0.007
1,2-	NA	NA	NA	0.05
Dichloroethylene,d4	NA	NA	NA	0.05
Toluene, d8*	NA	NA	NA	0.05
4-BromoFluorobenzene*				

U = Undetected
NA = Not Analyzed

* Constituents analyzed in the laboratory for information, but not identified in Table 1-1.

Table 3-6. Filtered Screening Analyses of Processed Effluent Samples Collected for Test #1. (Serne et al. 1993)

Constituent	Run 1 (mg/L)	Run 2 (mg/L)
Al	0.27	0.325
B	3	3.0
Ba	0.03	0.03
Ca	7.8	7.5
Cr	0.075	0.098
Cu	0.014	0.015
Fe	0.44	0.43
K	2.5	1.9
Mg	1.37	0.99
Mn	0.007	0.008
Na	90	114
Si	3.2	3.2
Sr	0.035	0.032
Zr	0.016	0.012
U-238	24.2	34.4
U-235	0.184	0.297
pH	8.07	8.19
F	0.79	3.2
Cl	5.4	3.6
NO_3	3.9	4.4
SO_4	24.1	32.3
HCO_3	175(est)	210(est)
TOC	2.85	3.95
	(meq/l)	(meq/l)
Cations		
Ca	0.39	0.375
K	0.064	0.049
Mg	0.115	0.082
Na	3.869	4.935
UO_2	0.179	0.255
Anions		
F	0.042	0.168
Cl	0.152	0.102
NO_3	0.063	0.071
SO_4	0.502	0.673

Except as noted analyses are ICP for metals and IC for anions. A 0.45 millipore HA Filter was used.

A discussion of Volatile Organic Compounds (VOC) detected in Test #1 and Test #2 is included in Section 3.3.2.

Most contaminants were removed from the water after filtering, but uranium concentrations were still as high as 34 mg/L (purgewater acceptance standards are 0.59 mg/L for total uranium). This indicated that in spite of previous laboratory tests where uranium was not found in the water (Gerber et al. 1991), in this field test some of the uranium could not be filtered out of the process effluent. Therefore, precipitation or ion exchange water treatment will be required to treat process effluent.

Processed soils were sent to PNL for analytical screening by size fraction. Sieve analyses (Table 3-7) indicate that less than 2% of the particles were smaller than the desired cut in the >150-mm, 150- to 25-mm, and 25- to 2-mm process piles. About 18% of the soils retained on the 0.425-mm sieve were smaller than 0.425 mm. Of these, 13.6% were in the size range from 0.212 mm to 0.425 mm.

It was believed that primarily the "green material" was not broken down by the system in the field. Increased agitation during wet sieving likely resulted in additional breakdown of the particles.

Table 3-7. Test #1 Wet Sieve Analyses for Processed Soil Fractions, Average Distribution for Two Runs (Percent by weight). (Serne et al. 1993)

Fraction (mm)	>150	150-25	25-2	2-0.425	<0.425
>50.8	**96.7**	**87.56**	0	0	0
50.8-25.4	2.85	**11.26**	0	0	0
25.4-12.7	0	0.51	**31.9**	0	0
12.7-9.5	0	0.03	**22.5**	0	0
9.5-2.0	0.03	0.02	**44.5**	1.48	0.38
2.0-1.0	0.02	0.01	0.61	**16.72**	0.75
1.0-0.425	0.14	0.13	0.07	**63.61**	6.24
0.425-0.212	0.08	0.18	0.05	13.62	**75.68**
0.212-0.15	0.02	0.04	0.02	0.69	**7.75**
0.15-0.075	0.05	0.08	0.02	0.59	**5.68**
0.075-0	0.11	0.18	0.33	3.29	**3.52**

* bold indicates size fraction that should be in the pile.

After wet sieving and determining the size fraction of soils in each of the piles, soils from the same size fractions were composited for XRF measurements and counting gamma activity levels. The results (Table 3-8) show that contaminants are primarily partitioned to the fine soil particles in each of the fractions, and contaminants were below performance levels specified in the test plan in the soil fractions >0.212 mm. Therefore after processing in the field and wet sieving in the laboratory, >93% by weight of the soils sieved met test performance levels. Schematics showing the distribution of ^{238}U, ^{235}U and ^{60}Co by particle size are given in Figures 3-2a, 3-3a, and 3-4a

Table 3-8. Test #1 Size Distribution of Contaminants in Processed Soils After Wet Sieving. (Serne et al. 1993)

Size (mm) / Contaminant	+50.8	25.4	12.7	9.5	2	1	0.425	0.212	0.15	0.075	0
Gamma Spec	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Co-60	0.06	0.1	0.25	1.5	2.3	3.9	4.5	3.2	1.6	4.5	6.0
Cs-137	0.05	0.05	0.25	1.1	2.3	3.8	2.5	2.4	2.3	5.0	6.0
U-235	0.26	0.10	0.30	0.8	19.5	37	16.5	15.0	24.5	46.5	149.5
U-238	1.92	0.58	2.3	4.6	149	284	147.5	119.5	232	461	1083
XRF mg/kg except as specified*											
Al (%)**	NA	NA	NA	NA	10.42	8.26	7.60	7.36	7.83	8.52	9.65
Si (%)	NA	NA	NA	NA	18.5	21.1	27.6	27.8	25.0	20.2	14.9
P (%)	NA	NA	NA	NA	0.233	0.335	0.182	0.182	0.248	0.349	0.438
S (%)	NA	NA	NA	NA	0.033	0.070	0.045	0.037	0.041	0.046	0.075
K (%)	NA	NA	NA	NA	0.79	1.02	1.38	1.46	1.29	1.09	0.91
Ca (%)	NA	NA	NA	NA	4.96	4.35	3.60	3.07	3.87	4.70	4.32
Ti (%)	NA	NA	NA	NA	1.08	0.75	0.73	0.59	0.77	0.68	0.48
V	NA	NA	NA	NA	323	183	159	108	163	120	21
Cr	NA	NA	NA	NA	152	240	130	163	259	410	677
Mn	NA	NA	NA	NA	1217	845	738	651	884	852	729
Fe (%)	NA	NA	NA	NA	7.16	5.06	4.40	3.79	5.26	4.79	3.24
Ni	NA	NA	NA	NA	302	473	190	218	359	589	866
Cu	NA	NA	NA	NA	3379	5943	2010	2166	3460	5933	8145
Zn	NA	NA	NA	NA	133	128	88	86	116	141	219
As	NA	NA	NA	NA	5.1	4.8	4.8	4.6	6.8	6.4	8.1
Se	NA	NA	NA	NA	1.9	1.9	1.8	1.7	1.9	1.9	1.9
Rb	NA	NA	NA	NA	39	79	59	63	67	92	196
Sr	NA	NA	NA	NA	327	339	375	382	375	368	431
Zr	NA	NA	NA	NA	1326	2104	754	820	1308	2143	3290
Ag	NA	NA	NA	NA	25	38	14	22	32	58	91
Cd	NA	NA	NA	NA	8.9	9.3	8.5	9.0	8.9	9.5	9.0
Sn	NA	NA	NA	NA	33	64	26	30	61	87	190
Ba	NA	NA	NA	NA	573	897	950	975	1088	1405	3513
Hg	NA	NA	NA	NA	7.6	8.6	5.3	5.3	6.8	8.8	10.3
Pb	NA	NA	NA	NA	38.2	67.1	39.2	46.2	65.0	103.8	155.5
U					1179	2291	983	858	1425	2493	7078
Ux0.35*** pCi/g	NA	NA	NA	NA	235	457	232	115	404	746	1939

NA = Not Analyzed
* Metals are averages for one run only; data for the second run was similar and is included in the PNL report (Serne et al. 1993)
** 1 % is equivalent to 10,000 mg/kg.
*** Conversion factor for total uranium (mg/kg) to pCi/g

respectively. Estimated concentrations of ^{238}U, ^{235}U and ^{60}Co in each of the process piles are shown in Figures 3-2b, 3-3b, and 3-4b. Values shown were calculated considering the activity levels in each fraction of soils (see Table 3-8) and the distribution of soils for each process pile (see Table 3.7).

Uranium concentrations were still as high as 100 pCi/g in material up to 1 to 2 mm in diameter. This is probably because the "green material" did not break down completely. Although test performance levels were met in the coarse soil fraction, concentrations were still as high as 149 pCi/g in the 2-to 9.5-mm fraction of material.

Increasing trommel retention time in the June 27 run resulted in better breakdown of particles in the trommel, as shown by <0.10% of the particles <2 mm in the 2-mm to 25-mm pile (Table 3-9), as compared 1.1% (see Table 3-7); and an increase in the amount of fines in the 0.425-mm to 2-mm pile, where over 25% of the particles were smaller than 0.425 mm. Addition of water sprays to flush the 0.425-mm screen or increasing the screen angle may be needed to break down particles between 2 mm and 0.425 mm in size. About 7% of the -0.425-mm material going to the frac tanks was slightly larger than the desired size fraction.

Attrition scrubbing laboratory tests were conducted to break down the particles (believed to be mostly green material) and thereby reduce radioactivity levels in processed soil particles between 2 mm and 0.425 mm. Tests were conducted using an attrition scrubbing unit obtained for 100 Area soil-washing laboratory tests. The attrition scrubber simulates a commercial unit (Freeman et al. 1993). It has counter current impellers that rotate at a selected speed and time to determine energy input requirements. Based on 100 Area tests, 2% to 5% additional fines are created in the attrition scrubbing process. Ideally, time, speed, and slurry density would be determined for the soils and contaminants being tested; however, due to time constraints, 100 Area attrition scrubbing parameters were used.

Table 3-10 compares particle size distribution for three tests conducted using soil samples collected from the 0.425- to 2-mm processed material. These are dry screened, wet screened, and attrition scrubbed followed by wet screening. Table 3-10 shows significantly more fine soils after attrition scrubbing and less coarse material than for the wet- or dry-sieved material, indicating that particles were broken down using the scrubber.

Table 3-11 and Figures 3-5a, 3-6a, and 3-7a show that following scrubbing, contaminant concentrations were much lower in each of the wet-sieved size fractions. Estimated concentrations of ^{238}U, ^{235}U and ^{60}Co representative of each process pile are shown in Figures 3-5b, 3-6b, and 3-7b. Values shown were calculated considering the activity levels in each fraction of soils before and after attrition scrubbing (Table 3-11) and the size distribution of soils for each process pile (see Table 3-7).

The results of the attrition scrubbing tests conducted in the laboratory indicate that the addition of a commercial attrition scrubber to the soil-washing system to further break down agglomerated soil particles may be

Figure 3-2a. Test #1, Wet-Sieved Size Distribution of Processed Soils, ^{238}U Gamma Spectrometry. (Serne et al. 1993)

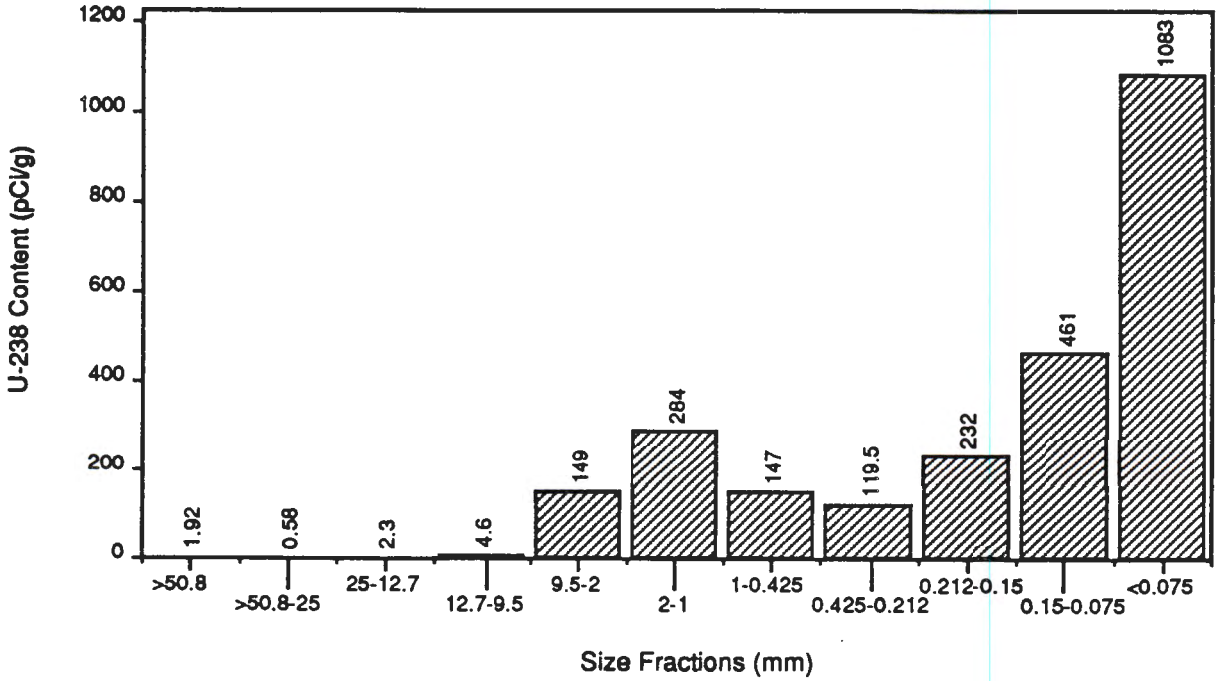

Figure 3-2b. Test #1, Contaminant Concentrations in Each Process Pile, ^{238}U Gamma Spectrometry.

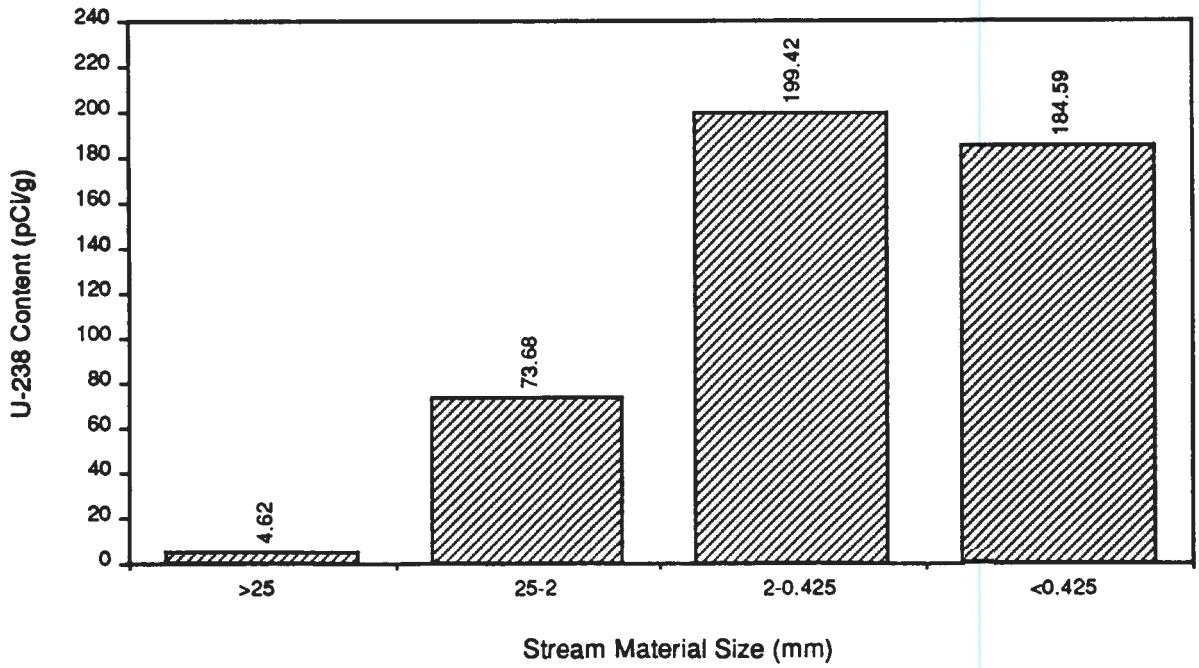

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Figure 3-3a. Test #1, Wet-Sieved Size Distribution of Processed Soils, ^{235}U Gamma Spectrometry. (Serne et al. 1993)

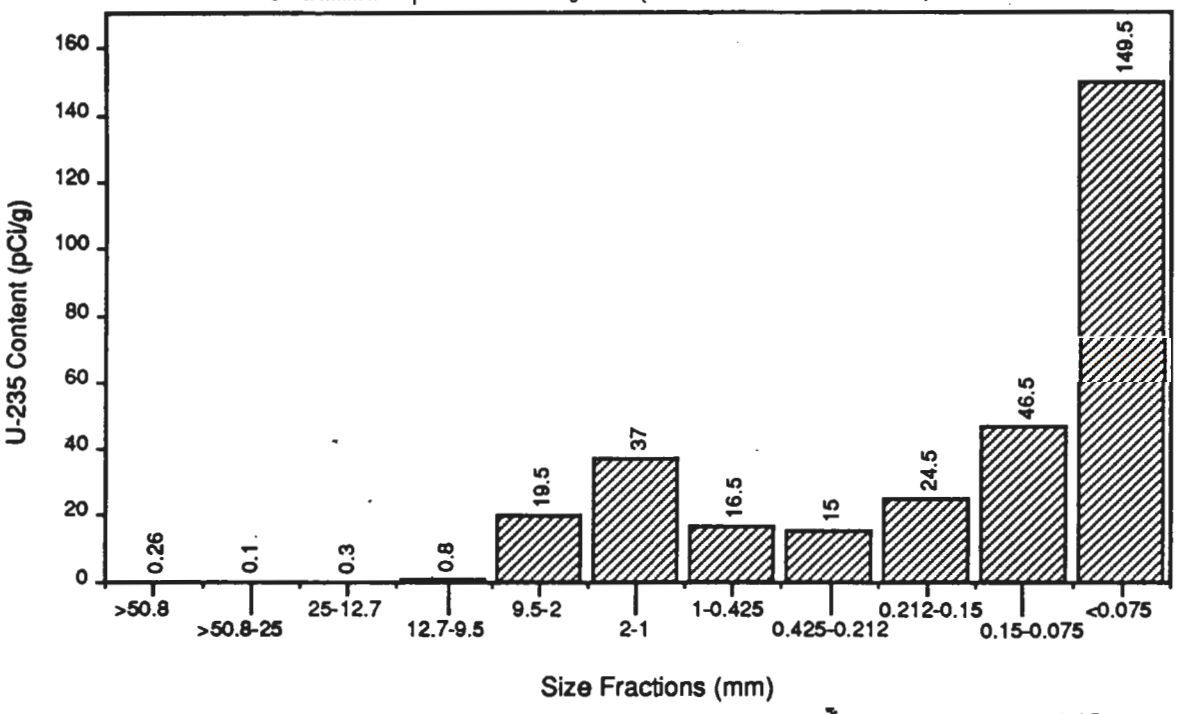

Figure 3-3b. Test #1, Contaminant Concentrations in Each Process Pile, ^{235}U Gamma Spectrometry.

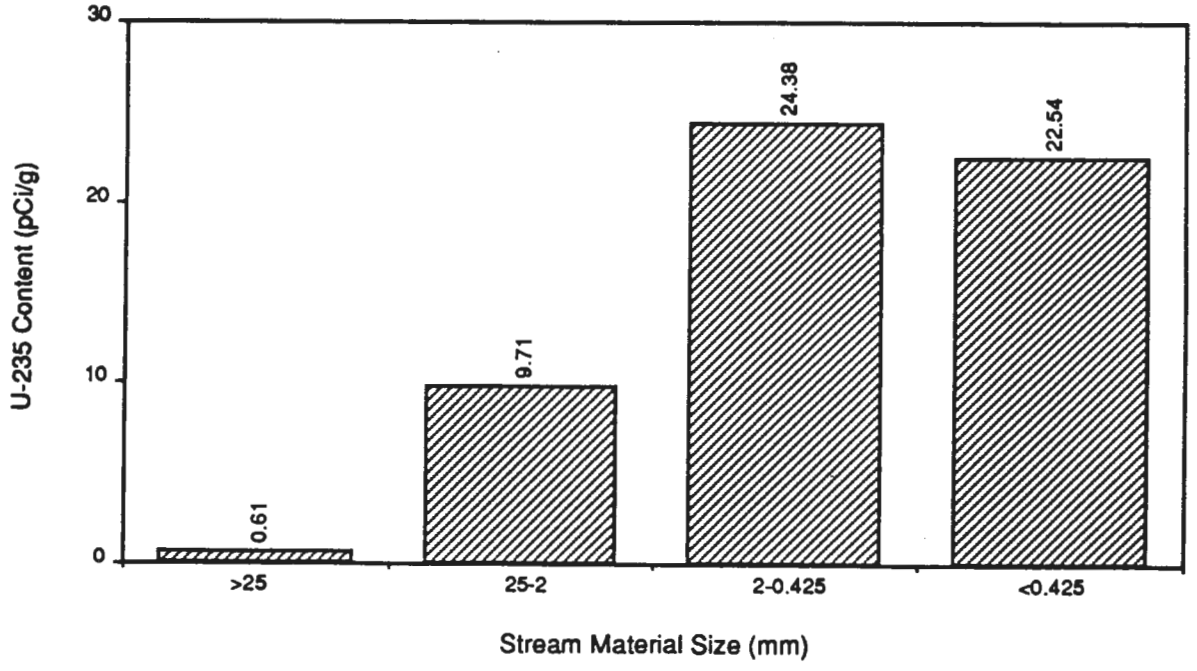

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Figure 3-4a. Test #1, Wet-Sieved Size Distribution of Processed Soils, ^{60}Co Gamma Spectrometry. (Serne et al. 1993)

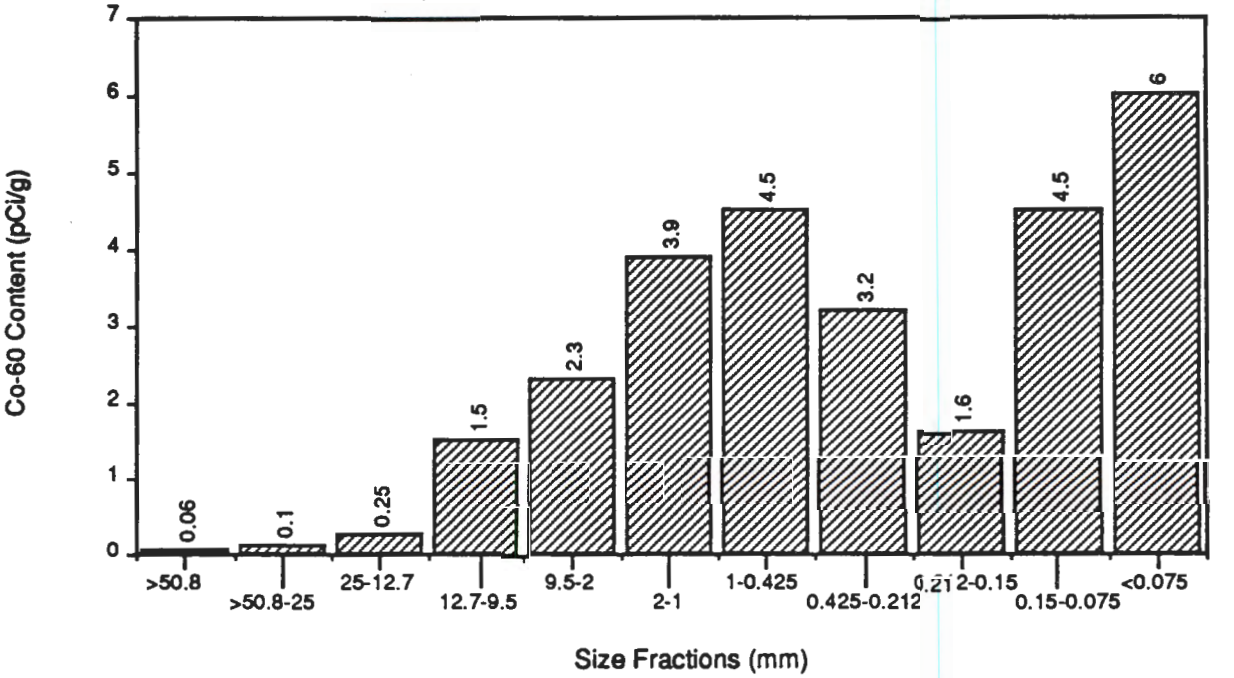

Figure 3-4b. Test #1, Contaminant Concentrations in Each Process Pile, ^{60}Co Gamma Spectrometry.

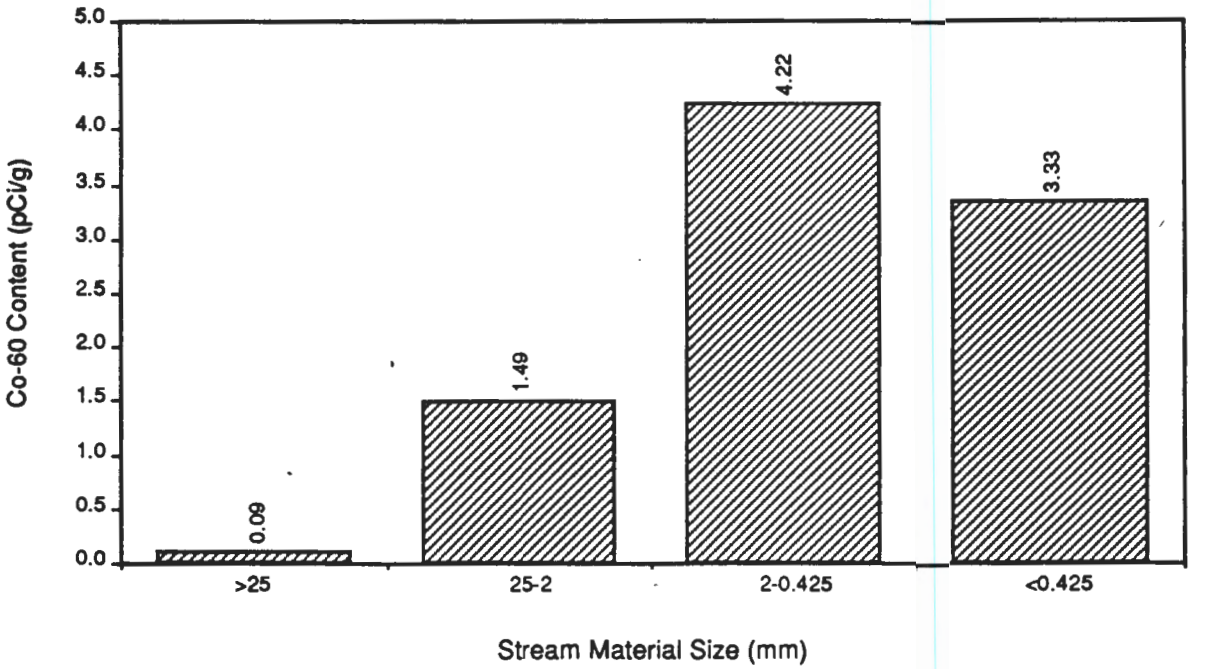

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Table 3-9. Test #1, June 27 Run, Wet-Sieved Analyses for Processed Soil Fractions (Percent by Weight). (Serne et al. 1993)

Size (mm)	Process Pile 25 to 2 mm	2 to 0.425 mm
25 to 13 mm	**92.45**	0.00
13 to 9.5 mm	**5.76**	0.00
9.5 to 2 mm	**1.69**	0.75
2 to 1 mm	0.05	**12.33**
1 to 0.425 mm	0.01	**62.50**
0.425 to 0.212 mm	0.01	22.80
0.212 to 0.150 mm	0.00	1.11
0.150 to 0.075 mm	0.00	0.52
<0.075 mm	0.03	1.31

Bold indicates size fraction that should be in the pile.

Table 3-10. Test #1 Size Distribution of Dry-Sieved, Wet-Sieved, and Attrition Scrubbed/Wet-Sieved Soil Samples from the 0.425- to 2-mm Process Pile (Percent by Weight). (Serne et al. 1993)

Particle Size (mm)	Wet Sieved	Dry Sieved	Attrition/Wet Sieved
+50.8	0.00	0.00	0.00
25.4-50.8	0.00	0.00	0.00
12.7-25.4	0.00	0.00	0.00
9.5-12.5	0.00	0.00	0.00
2-9.5	2.53	0.65	0.41
1-2	20.27	10.87	9.91
0.425-1	62.24	66.06	62.0
0.212-0.425	11.63	20.38	13.08
0.15-0.212	0.52	0.70	0.49
0.075-00.15	0.43	0.53	0.43
< 0.075	2.37	0.83	13.68

Table 3-11. Size Distribution of Radiochemical Isotopes After Attrition Scrubbing, Test #1.

Particle Size (mm)	U-238 (pCi/g)	U-235 (pCi/g)	Co-60 (pCi/g)	Cs-137 (pCi/g)
2 to 9.5	33.7	4.1	5.37	5.05
1 to 2	28.1	2.8	0.97	0.70
0.425 to 1	50.8	6.3	0.90	0.46
0.212 to 0.425	35.4	3.8	1.54	1.68
0.15 to 0.212	75.2	10.4	6.68	3.92
0.075 to 0.15	190	14.0	19.9	14.9
< 0.075	777	103	8.82	7.47

The results of the attrition scrubbing tests conducted in the laboratory indicate that the addition of a commercial attrition scrubber to the soil-washing system to further break down agglomerated soil particles may be sufficient to achieve test objectives for processing soils containing "green material."

3.2.3 Discussion of Results

Some differences between offsite laboratory results and PNL gamma spectrometry and XRF results for feed soils should be mentioned here. Almost without exception, analysis of the offsite laboratory feed soils showed that soil concentrations in the feed soils and in the processed streams were higher than gamma spectrometry or XRF analyses conducted by PNL for the same constituents. In both sets of analytical laboratories, instruments were calibrated daily to a known standard.

One explanation for the differences may be that processed soils were wet sieved in the PNL laboratories and more of the uranium contaminants solubilized into the water used for wet sieving. Another potential explanation may be that in spite of efforts to obtain representative samples and duplicate samples for the laboratories, there was a spatial variability in the samples.

A difference was noted in Test #1 between total uranium analyses using XRF (mg/kg) and converting to activity levels pCi/g (2.2 times higher) and uranium isotope analyses using gamma spectrometry to measure activity levels pCi/g (lower). Because XRF analyses are closer to offsite laboratory results and because uranium is primarily an alpha emitter with gamma emissions and gamma measurements are less sensitive, XRF is likely the more accurate of the two. Investigations into these discrepancies are further addressed in Serne et al. (1993).

Figure 3-5a. Test #1 Distribution of ^{238}U by Particle Size, Before and After Attrition Scrubbing. (Serne et al. 1993).

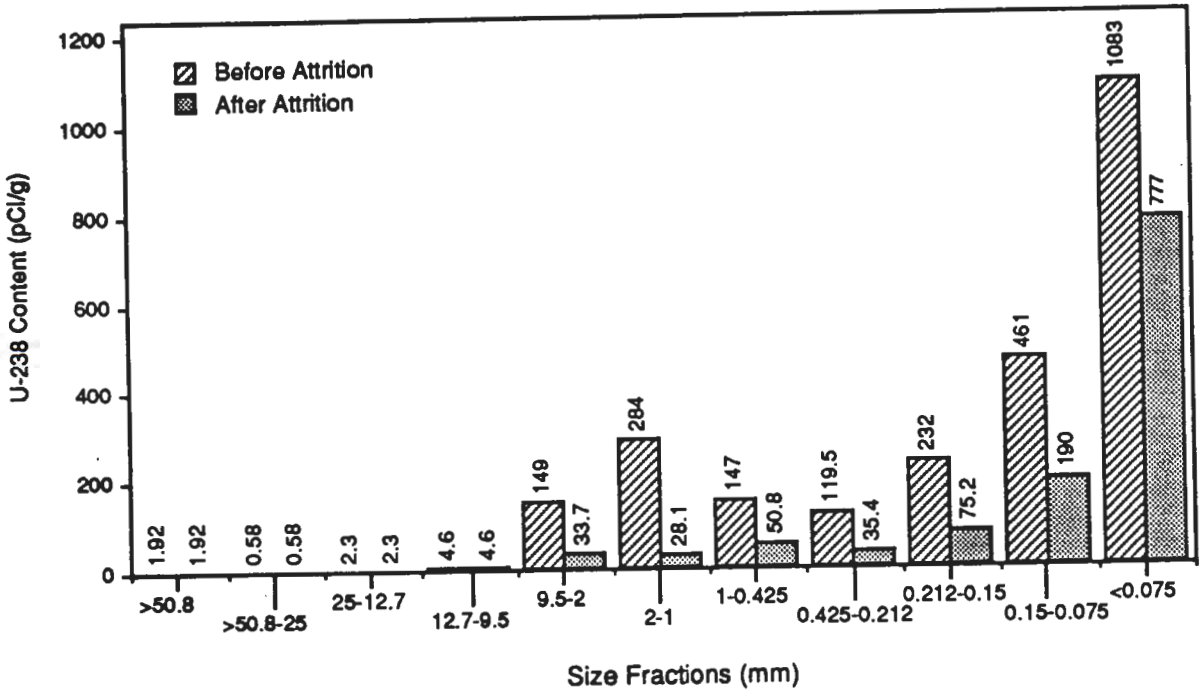
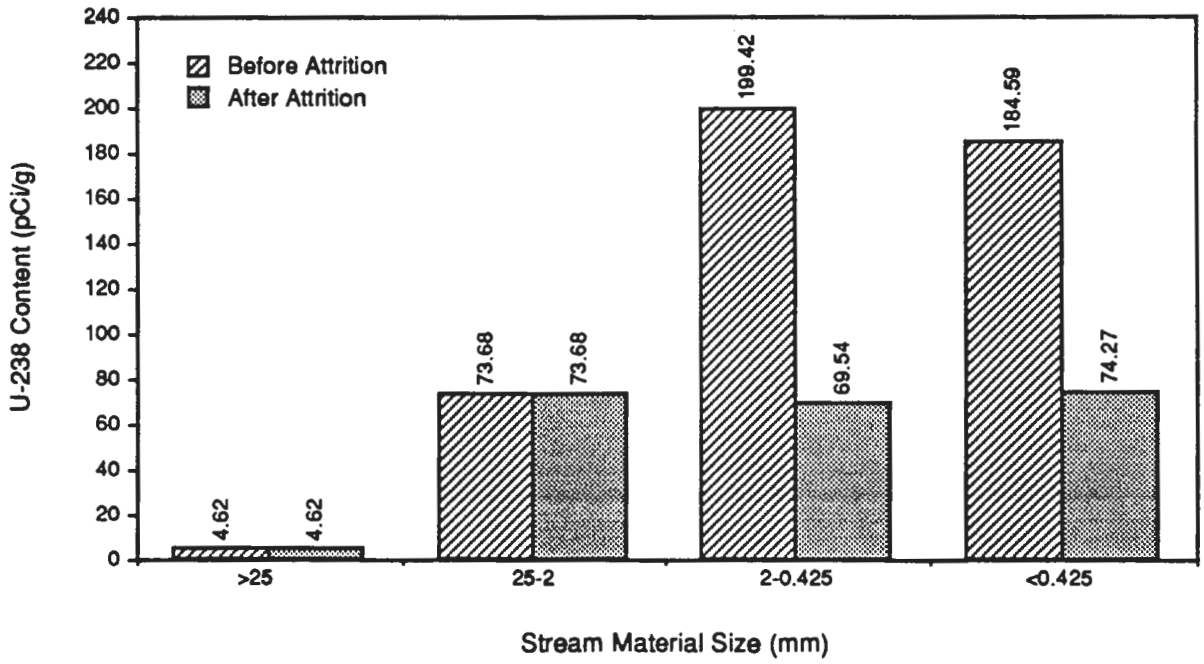


Figure 3-5b. Test #1 ^{238}U Levels in Each Process Pile Size Fraction, Before and After Attrition Scrubbing. (Serne et al. 1993).



GEN\M3.5

Figure 3-6a. Test #1 Distribution of ^{235}U by Particle Size, Before and After Attrition scrubbing. (Serne et al. 1993).

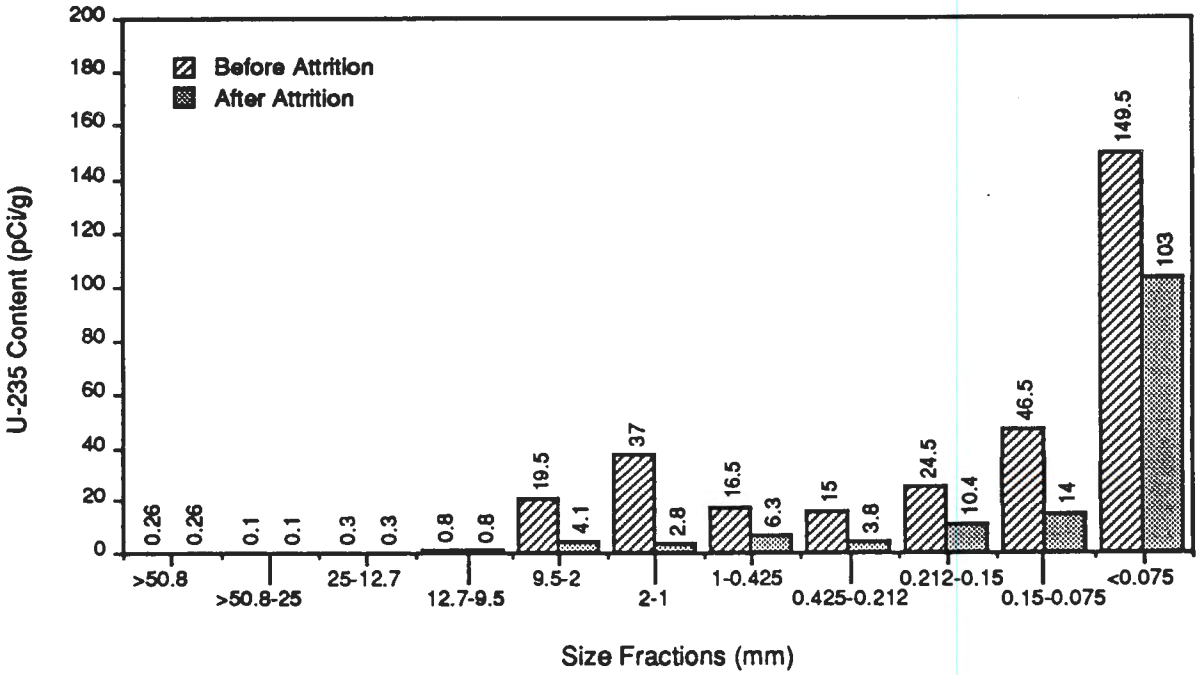
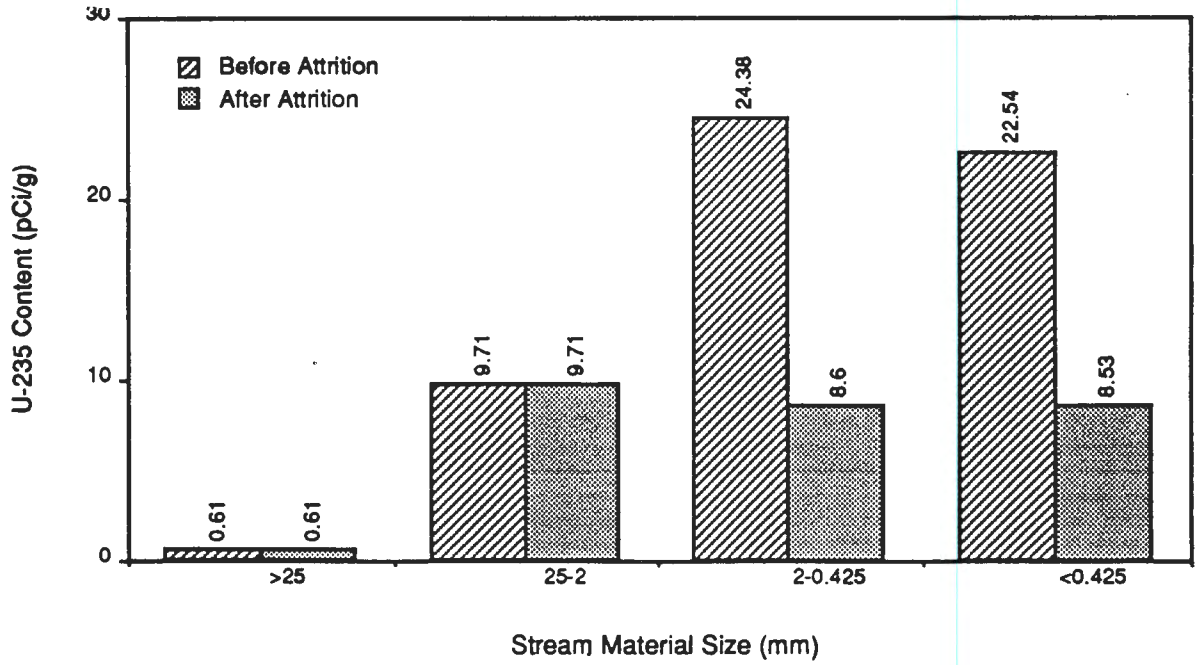


Figure 3-6b. Test #1 ^{235}U Levels That Would Be in Each Process Pile Size Fraction, Before and After Attrition Scrubbing. (Serne et al. 1993)



GEN\M3.6

Figure 3-7a. Test #1 Distribution of ^{60}Co by Particle Size, Before and After Attrition Scrubbing. (Serne et al. 1993)

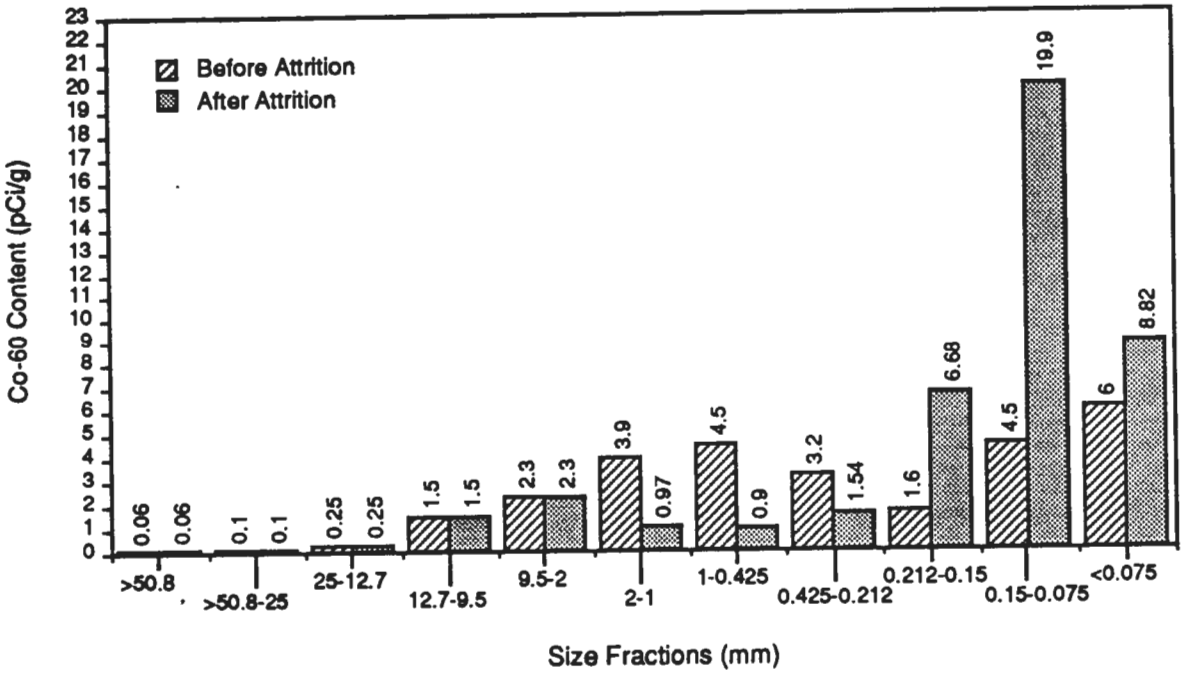
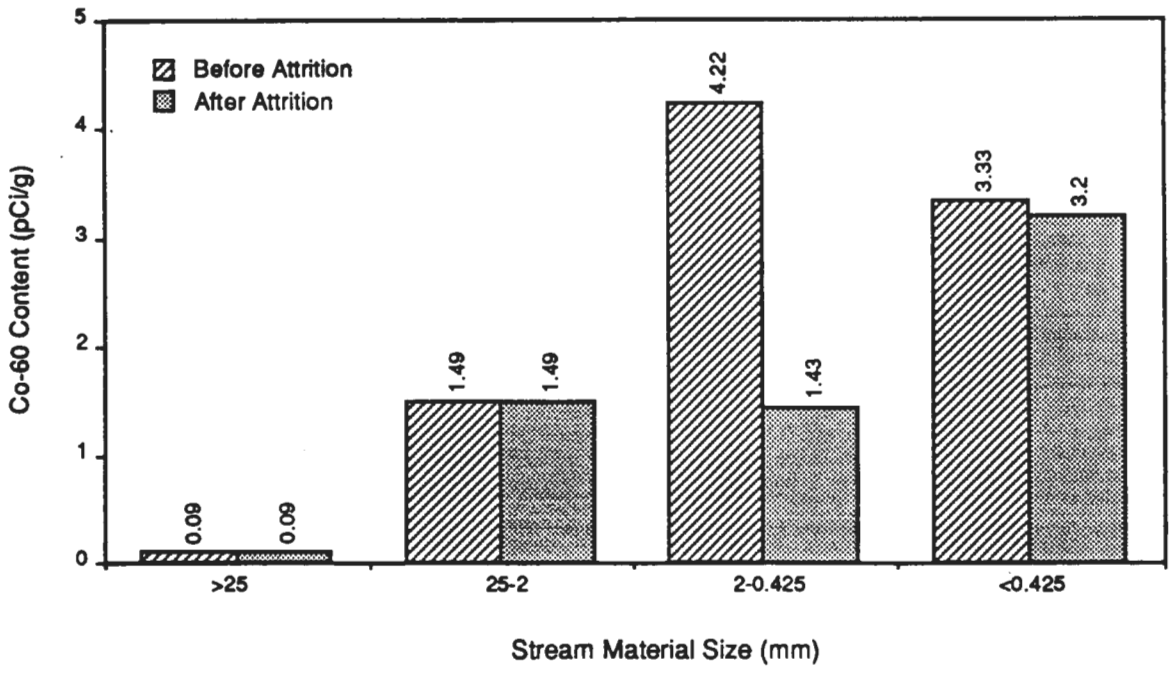


Figure 3-7b. Test #1 ^{60}Co Levels That Would Be in Each Process Pile Size Fraction, Before and After Attrition Scrubbing. (Serne et al. 1993)



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Another noted discrepancy in the data was that the concentration of uranium isotopes in feed soils was higher than the concentration in the processed soil fractions. The reason for this was that much of the uranium remained in suspension in the effluent or was solubilized. A rough mass balance illustrates this, as follows.

> The concentration of uranium (see Table 3-5) was 791 pCi/g in the 25- to 2-mm fraction, 650 pCi/g in the 0.425- to 2-mm fraction, and 329 pCi/g for soils <0.425 mm. A weighted average of these comes out to 625 pCi/g based on the distribution in Figure 3-1b. The concentration of uranium in the <25-mm feed soils was 1802 pCi/g (see Table 3-2). The difference between feed soils and processed soils is 1177 pCi/g, rounded to 1200 pCi/g. Since approximately 4.3 tons of <2-mm soil was processed in Test #1 (see Figure 2-1a), this gives a total radioactivity level of 5.26 E 9 pCi that is not accounted for and that should have accumulated in the process effluent.
>
> Approximately 91,000 L of effluent was processed in Test #1. After processing, unfiltered effluent contained approximately 40,000 pCi/L of uranium activity. Multiplied, this is 3.6 E 9 Ci of uranium, which is within the same order of magnitude as the difference in soil activity levels before and after processing.

3.3 TEST #2 RESULTS

The following is a description and summary of data analyses obtained as part of Test #2. More complete data analyses are included in Appendix B.2 and a the PNL report (Serne et al. 1993).

Samples and HEIS numbers of samples collected during Test #2 are shown in Table 2-3.

3.3.1 Analysis of Waste Stream

In Test #2, soils were processed that contained lower concentrations of contaminants as compared to Test #1 and that were free of the "green material." The purpose of the test was to determine whether the modified trommel and screening system (Section 2.2.3) would meet test performance levels processing this type of material. RI Phase I investigations show that most of the potential area to be remediated in the process ponds will not contain the "green material," and a simpler system such as this may be all that is needed to remediate the majority of the 300-FF-1 OU.

A summary of physical characteristics of the low-activity feed soils processed in Test #2 is shown in Table 3-12 and Figure 3-8a. The percent of soils in each process pile is shown in Figure 3-8b. The soils were located from waste piles at four locations in the process pond shown in Figure 1-2. These soils contained significantly fewer fine particles (<0.425 mm) than those processed in Test #1.

Table 3-12. Test #2, Wet-Sieved Size Distribution of Feed Soils. (Serne et al. 1993).

Size Fraction	Distribution (%)
> 50.8 mm	63.2
25 mm to 50.8 mm	16.8
2 mm to 25 mm	15.7
0.425 mm to 2 mm	2.9
0.212 mm to 0.425 mm	0.45
0.15 mm to 0.212 mm	0.10
0.075 mm to 0.15 mm	0.15
<0.075 mm	0.85

Field measurements showed that the activity of soils processed was near background levels (500 dpm).

Laboratory analyses showing the average concentration and standard deviation for chemical and radiochemical contaminants for feed soils and water are shown in Table 3-13. These data show that chemical and radiochemical constituents in soils processed for Test #2 were below test performance levels prior to processing.

3.3.2 Analysis of Processed Soils

On September 8, 1993, about 15 tons of soil was processed. Field measurements showed that the activity of feed soils and processed soils in each of the piles (25 mm to 150 mm, 2 mm to 25 mm, and 0.425 mm to 2 mm) was near background levels (500 dpm).

Soil and effluent samples were collected and sent for analyses to assess which contaminants were in each of the processed fractions and to determine what water treatment, if any, would be required to meet purgewater acceptance standards after processing lower activity soils in the north process pond. A summary of laboratory results is shown in Table 3-14. Additional data is included in Appendix B.2. Test #2 TCLP analytical data were not completed as of November 1993.

Data in Table 3-14 show that all the constituents in all the soil piles were below the performance limits for the test and that the concentration of uranium is highest in the fine soil fraction. The average activity of ^{238}U in soils <0.425 mm was 93.6 pCi/g as compared to 5.5 pCi/g in the feed soils.

Figure 3-8a. Average Wet-Sieved Size Distribution of Feed Soils in Test #2 (Percent by Weight). (Serne et al. 1993)

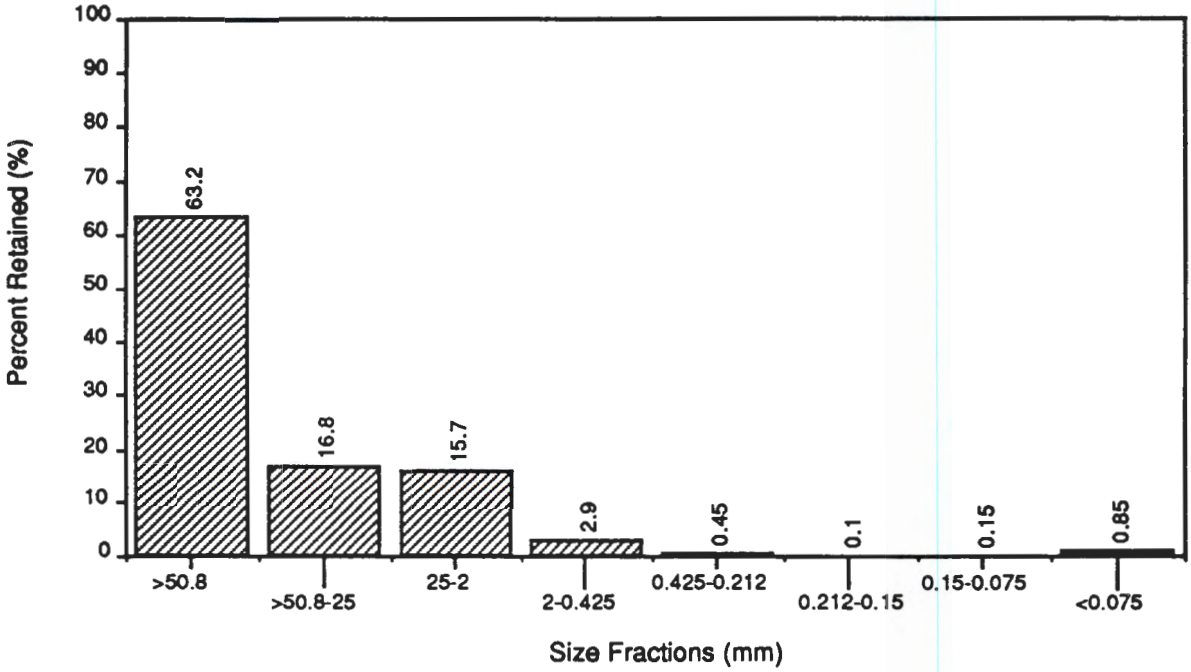

Figure 3-8b. Percent of Soils in Each Process Pile, Test #2 (Percent by Weight).

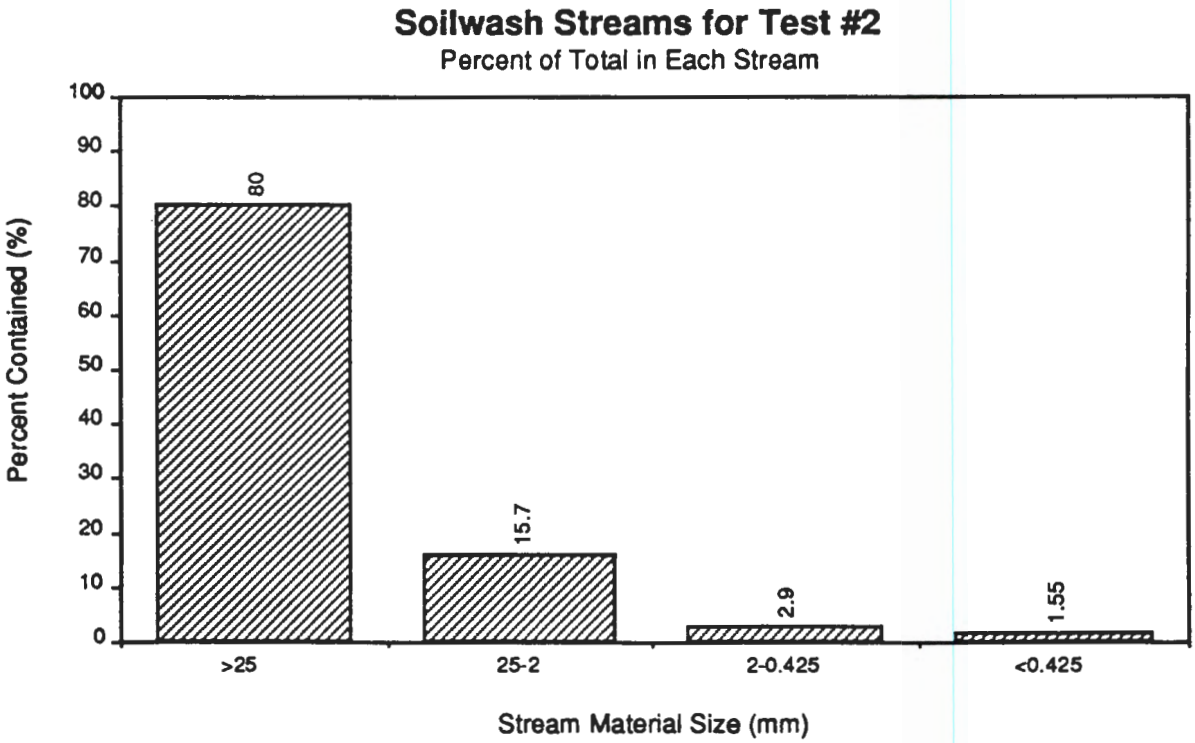

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Table 3-13. Test #2, Chemical and Radiochemical Analyses of Feed Soils <25 mm[1] and Feed Water (Appendix B.2).

	Feed Soils		Water	
Contaminant	Avg	S	Avg	S
	(pCi/g)	(pCi/g)	(pCi/l)	(pCi/l)
Co-60	0.116	0.102	2.809 U	2.144
Cs-137	0.062	0.020	3.075 U	1.112
Pb-212	0.591	0.058	NA	NA
Pb-214	0.475	0.027	NA	NA
Ra-224	0.594	0.058	NA	NA
Ra-226	0.440	0.065	NA	NA
Ru-106	0.040 U	0.120	0 U	U
Sb-125	0.009 U	0.030	0 U	U
			(ug/l)	(ug/l)
U-Nat	5.506	4.162	0.958	0.391
	(mg/kg)	(mg/kg)	(mg/l)	(mg/l)
Ag	3.6	0.92	0.002	0.002
Al	11320	2282	0.00	0.00
Ba	119.2	22.82	0.031	0.005
Be	0.33	0.10	0.00	0.00
Ca	7880	1038	28.3	5.76
Cd	0.00	0.00	0.00	0.00
Co	12.6	1.02	0.00	0.00
Cr	19.8	3.66	0.00	0.003
Cu	238	80.6	0.03	0.031
Fe	32600	1625	0.79	0.671
Hg	0.17	0.15	0.00	0.00
K	1294	368	2.20	0.51
Mg	6340	779	6.45	1.46
Mn	498	73.1	0.028	0.025
Na	446	17.4	5.80	2.18
Ni	28.8	4.79	0.00	0.00
Pb	5.68	1.32	0.012	0.015
Sb	4.82	2.46	0.00	0.00
Sn	0.00	0.00	0.00	0.00
V	88.2	1.72	0.0013	0.002
Zn	70.6	4.76	0.010	0.009
Organics			(mg/l)	(mg/l)
1,1,1-Trichloroethane	NA	NA	0.008U	0.0012U
1,1,2-Trichloroethane	NA	NA	U	U
1,1-Dichloroethane	NA	NA	U	U
1,2-Dichloroethane	NA	NA	U	U
1,4-Dichlorobenzene	NA	NA	U	U
1-Butanol	NA	NA	U	U
4-Methyl-2-pentanone	NA	NA	U	U
Acetone	NA	NA	U	U
Benzene	NA	NA	U	U
Carbon Disulfide	NA	NA	U	U
Carbon Tetrachloride	NA	NA	U	U
Chloroform	NA	NA	0.0014U	0.0029U
Ethyl Cyanide	NA	NA	U	U
Methyl Ethyl Ketone	NA	NA	0.005U	0.015U
Methylene Chloride	NA	NA	U	U
Tetrachloroethane	NA	NA	U	U
Tetrahydrofuran	NA	NA	0.0094U	0.0123U
Toluene	NA	NA	U	U
Trichloroethene	NA	NA	0.0001U	0.0003U
Vinyl Chloride	NA	NA	U	U
Xylenes (total)	NA	NA	U	U

S = Standard Deviation; U = Undetected; NA = Not Analyzed
1. Note - material > 25 mm are not able to be handled by the laboratory. Material between 25 mm and 2 mm was crushed to 2 mm or less and then analyzed.
2. Constituents analyzed in the laboratory for information, but not identified in Table 1.1.

Table 3-14. Test #2 Laboratory Analyses for Each of the Process Piles (Appendix B.2).

Contaminant	25-2	2-0.425	< 0.425	Filtered Water
	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/l)
Co-60	0.106	0.260	0.242	0 U
Cs-137	0.118	0.256	0.273	0 U
Pb-212	0.568	0.671	1.049	-
Pb-214	0.506	0.438	0.681	-
Ra-224	0.572	0.675	1.051	-
Ra-226	0.491	0.417	0.632	-
Ru-106	0 U	0 U	U	0 U
Sb-125	0 U	0 U	U	0 U
				(ug/l)
U-Nat	1.432	12.05	93.63	151.9
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/l)
Ag	0.91	4.00	4.73	0.011
Al	4292	7567	7867	8.05
Ba	70.0	93.1	220	0.32
Be	0.22	0.35	0.04	0.00
Ca	5450	7083	5067	25.8
Cd	0.00	0.00	0.00	0.00
Co	9.08	11.8	7.80	0.00
Cr	4.18	18.8	41.3	0.06
Cu	158	644	580	0.86
Fe	24583	33750	24333	5.87
Hg	0.00	0.22	0.25	0.00
K	309	569	683	3.19
Mg	3492	5533	4167	6.91
Mn	267	406	287	0.131
Na	328	478	367	7.84
Ni	9.19	31.3	38.3	0.058
Pb	1.93	4.93	13.0	0.012
Sb	1.70	2.25	0.00	0.00
Sn	0.00	0.00	6.83	0.00
V	63.9	98.5	70.7	0.010
Zn	51.3	106	75.7	0.044

Process effluent from Test #1 was filtered in the field using a 0.045-μm filter. Analyses showed that very little of the uranium in the filtered effluent was soluble in the water (Appendix B.2). As noted by the PNL report (Serne et al. 1993), this may have been due to a shorter contact time or to lower concentrations of uranium in the soils and little or no green material in the soils processed.

Analysis for VOCs was performed on the fresh water stream and the process water stream in Test #1 and Test #2. The detected VOCs and suspected sources of VOCs for both tests follow:

Chloroform--Found in Test #1 in fresh water and process water in equal concentrations and is most likely the result of chlorination. Not found in trip blanks. Test #2--Found only in fresh water stream at lower concentrations than Test #1. It was not detected in the process water or any of the blanks. All detects were well below purgewater acceptance standards. 1,2-Dichloroethane, Toluene, 4-BromoFluorobenzene--Found in Test #1 in equal concentrations in the fresh water and process water streams. But they were also found in the trip blanks at the same concentration. Indicates some type of sample contamination. Another indication of sample contamination is the fact that these were not detected anywhere in Test #2.

1,1,1-Trichloroethane--This was detected only in Test #2 in a fresh water duplicate (not the matching sample) and in two of five process water samples. All three samples are below the contract required quantitation limit (CRQL) but above the method detection limit (MDL), which is denoted by an "L" qualifier in the data (Appendix B). This is a derivative of chloroform and is the most likely source. No limit is given in the purgewater acceptance standards.

Methyl Ethyl Ketone and Tetrahydrofuran--These compounds are in the glue used to seal some of the PVC lines in the process. In Test #1, Methyl Ethyl Ketone was detected in five of seven process water samples and in Test #2 in only one of five process water samples. All detects were well below purgewater collection criteria. It was never detected in the fresh water stream. Tetrahydrofuran was detected one of seven process water samples in Test #1 and all five process water samples for Test #2. It was also detected in a duplicate fresh water sample but not in its mate. There is no purgewater acceptance standard for this compound.

Tetrachloroethylene (PCE), Trichloroethylene (TCE)--These compounds were detected only in Test #1 process water samples. They were below the purgewater acceptance standard in all of the process water samples taken in Test #1.

Polychlorinated Biphenyls (PCB)--These were analyzed for in Test #2 only. Aroclor-1248 was the only PCB detected. It was detected below test performance levels (2,200 ppb) in all soils

(raw feed, 25 mm to 2 mm, 2 mm to 0.425 mm, and <0.425mm) and in the process water (see Table 1-1). The raw feed had detects in all five samples averaging 59 ppb with a high of 120 ppb and a low of 12 ppb. For the 25-mm to 2-mm soils, samples averaged 7 ppb with a high of 29 ppb and a low of 2.4 ppb. For the 2-mm to 0.425-mm soils, samples averaged 292 ppb with a high of 440 ppb and a low of 190 ppb. The highest concentrations were found in the three slurry soil samples with the highest being 970 ppb. It was found in five of eight process water samples. Using zero for the nondetects, the average was 0.35 ppb with a high of 1.3 ppb and a low of zero. In comparison, the purgewater acceptance standard for mixed PCBs is 1 ppb.

Processed samples were also sent to PNL to be analyzed by size fraction. Sieve analyses for each of the process piles in Test #1 (see Table 3-7) and Test #2 (Table 3-15) show that the three screening units in the system performed well within normal operating parameters for this equipment.

Table 3-15. Sieve Analyses for Soil Fractions Processed in Test #2 (Percent by Weight). (Serne et al 1993)

Fraction (mm)	150-25	25-2	2-0.425	<0.425
>50.8	**95.42**	0.00	0.00	0.00
50.8-25.4	**4.26**	0.00	0.00	0.00
25.4-12.7	0.00	**14.46**	0.00	0.00
12.7-9.5	0.00	**18.78**	0.00	0.00
9.5-2.0	0.02	**63.79**	1.21	0.03
2.0-1.0	0.01	2.92	**27.32**	1.28
1.0-0.425	0.05	0.02	**62.86**	2.65
0.425-0.212	0.03	0.01	5.86	**51.78**
0.212-0.15	0.01	0.00	0.08	**9.58**
0.15-0.075	0.02	0.02	0.09	**11.07**
0.075-0	0.17	0.01	2.58	**23.61**

Bold indicates size fraction that should be in the pile.

For the following discussion, efficiency is defined as the percent of material in the feed to a particular screen that actually passes through compared to the amount available to pass through.

The 25-mm primary screen operated in excess of 95% efficiency for both tests and closer to 99% for Test #2. Despite this high efficiency, fines in the +25-mm material in Test #1 did result in contamination of that stream. Therefore, it is essential that the full-scale system employ an effective wet-screening stage for this material.

The trommel efficiency was a little more varied. For Test #1, the efficiency was very high at approximately 99%, while Test #2 was lower at

about 90%. The difference can be explained by the difference in the makeup of the material going to the trommel. In Test #1 the feed was made up of a much higher percentage of fines than Test #2 (56% and 22% respectively). In both tests the trommel made very acceptable separations; however, in Test #1 the trommel was more efficient by definition because there were a lot more fines to screen out.

The final screening unit, the 0.425-mm secondary screen, operated at 82% for Test #1 and 85% efficiency for Test #2. As with the trommel, the feed to the secondary screen during Test #1 had more fines (51% to 35% for Test #2). One would therefore expect the efficiency in Test #1 to be higher than in Test #2 if all other factors were equal. However, a water spray was utilized during most of Test #2 to help improve the separation made by this screen. It appears that it may have done just that.

This screen experienced a certain amount of blinding off that will reduce the unit's efficiency. Full-scale operations will require either a different method for making the final cut (i.e., hydrocyclones or counter-current columns) or additional units to facilitate a schedule for the shutdown of some units for cleaning without interrupting the processing.

After sieving and determining the size fraction of soils in each of the piles, soils from the same size fractions were composited for XRF measurements and counting gamma activity levels. The results (Table 3-16) show that contaminants are primarily partitioned to the fine soil particles in each of the fractions. The distribution of ^{238}U, ^{235}U, and ^{60}Co in each of the sieved size fractions is shown in Figures 3-9a, 3-10a, and 3-11a respectively. Estimated concentrations of ^{238}U, ^{235}U and ^{60}Co in each of the process piles are shown in Figures 3-9b, 3-10b, and 3-11b.

Values shown were calculated considering the gamma spectrometry measured activity levels in each fraction of soils (see Table 3-16) and the distribution of soils for each process pile (see Table 3-15). As in Test #1, ^{238}U is the primary contaminant, with the highest concentration in soil particles less than 0.212 mm in diameter. The concentrations of metals were as expected in this run: generally decreasing as the size fraction of soils increases.

Both the analytical data and the screening analyses show that the physical separations process tested separated soils so that radioactivity levels in soils greater than 0.425 mm in diameter were reduced as compared to the radioactivity of finer soils. Based on PNL wet-sieving analysis (see Table 3-12) a reduction of 98% by weight may be possible if soils are separated at 0.425 mm, and a reduction of 99% by weight may be possible if the cut point is 0.15 mm.

3.3.3 Higher Activity Field Screening

A final run was made using "green material" from one of the piles on the west side of the trench. The trommel speed was increased to 7 rpm to provide more energy to separate soils. The radioactivity of the field soils was measured at 6,000 to 13,000 dpm with an average of 9,000 dpm. After

Table 3-16. Test #2 Size Distribution of Contaminants in Processed Soils After Wet Sieving. (Serne et al. 1993)

Contaminant	+50.8	25.4	12.7	9.5	2	1	0.425	0.212	0.15	0.075	0
Gamma Spec	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Co-60	0.06	0.04	0.27	0.27	0.3	0.4	0.3	0.5	0.8	1.4	2.5
Cs-137	0.05	0.12	0.09	0.38	0.3	0.4	0.5	0.5	0.8	5.7	2.6
U-235	0.04	0.07	0.05	0.14	0.2	0.6	1.0	2.3	3.2	4.9	1.0
U-238	0.17	0.45	0.72	0.67	0.9	2.9	5.8	15.2	23.3	35.0	54.0
XRF mg/kg except as specified*											
Al (%)**	NA	NA	NA	NA	6.40	7.08	6.44	5.91	6.4	6.81	9.18
Si (%)	NA	NA	NA	NA	26.0	25.8	24.0	26.6	26.2	25.6	23.4
P (%)	NA	NA	NA	NA	0.08	0.09	0.10	0.07	0.07	0.076	0.064
S (%)	NA	NA	NA	NA	0.05	0.04	0.038	0.036	0.032	0.035	0.047
K (%)	NA	NA	NA	NA	1.36	1.12	1.06	1.34	1.34	1.32	1.87
Ca (%)	NA	NA	NA	NA	4.92	4.90	4.5	3.4	3.24	3.48	2.31
Ti (%)	NA	NA	NA	NA	1.34	1.37	1.32	0.96	0.95	1.04	0.70
V	NA	NA	NA	NA	436	462	448	308	311	346	203
Cr	NA	NA	NA	NA	18.7	39.3	33.5	85	107	117	193
Mn	NA	NA	NA	NA	1634	1393	1360	1044	1093	1258	1200
Fe (%)	NA	NA	NA	NA	8.49	8.68	8.48	6.13	6.73	8.00	5.89
Ni	NA	NA	NA	NA	20.4	36	46	61	66	102	182
Cu	NA	NA	NA	NA	120	300	716	997	1036	1425	2310
Zn	NA	NA	NA	NA	125	125	129	129	146	167	185
As	NA	NA	NA	NA	3.5	4.1	4.8	3.8	5.5	6	10.3
Se	NA	NA	NA	NA	1.3	1.3	1.3	1.2	1.3	1.2	1.1
Rb	NA	NA	NA	NA	41.0	31.0	34	52	54	55	108
Sr	NA	NA	NA	NA	322	311	328	370	345	347	267
Zr	NA	NA	NA	NA	188	201	230	516	556	698	971
Ag	NA	NA	NA	NA	12	13	13	15	16	21	48
Cd	NA	NA	NA	NA	13	14	17	15	15	12	13
Sn	NA	NA	NA	NA	14	16	15	21	28	22	20
Ba	NA	NA	NA	NA	794	644	614	670	682	673	890
Hg	NA	NA	NA	NA	5.0	5.0	5.0	4.8	5.0	5.0	4.7
Pb	NA	NA	NA	NA	8.0	5.0	6.8	17.2	20.3	26	38
U	NA	NA	NA	NA	9.0	9.4	21.6	82.4	86	97	186
pCi/g U*0.35***	NA	NA	NA	NA	3.2	3.3	7.6	28.9	30.1	34.0	65.1

NA = Not Analyzed
* Metals are averages for one run only; data for the second run was similar and is included in the PNL report (Serne et al. 1993)
** 1% is equivalent to 10,000 mg/kg.
*** Conversion factor for total uranium (mg/kg) to pCi/g

Figure 3-9a. Test #2, Wet-sieved Size Distribution of Processed Soils, ^{238}U Gamma Spectrometry. (Serne et al. 1993)

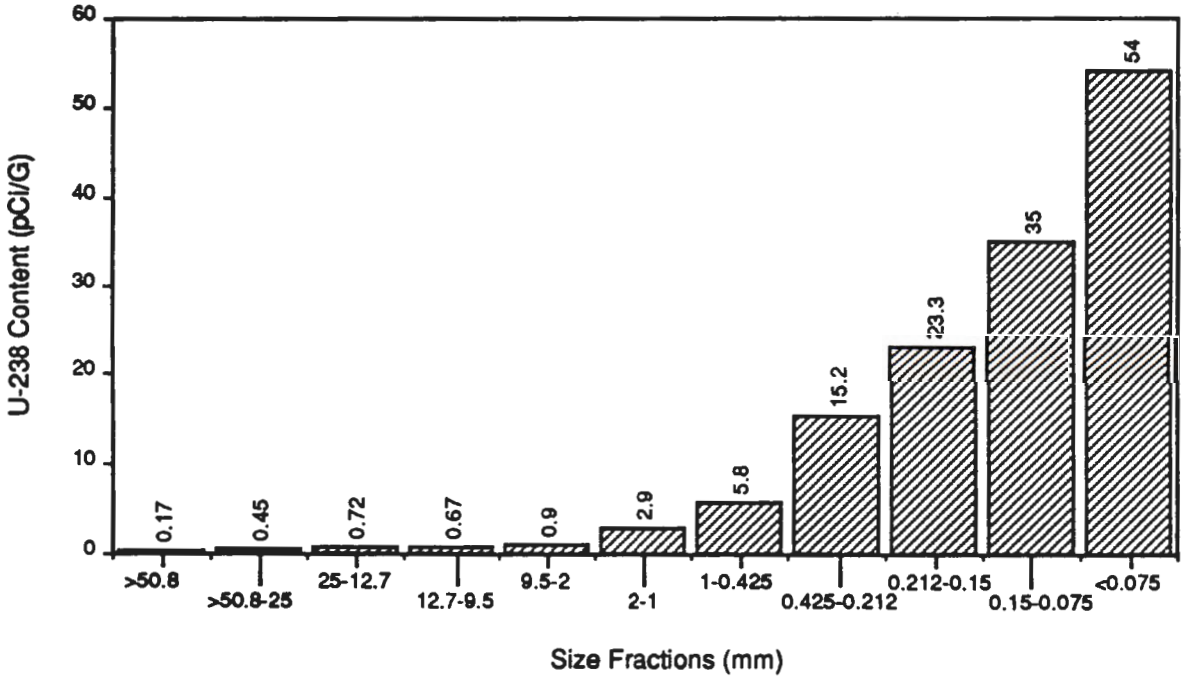
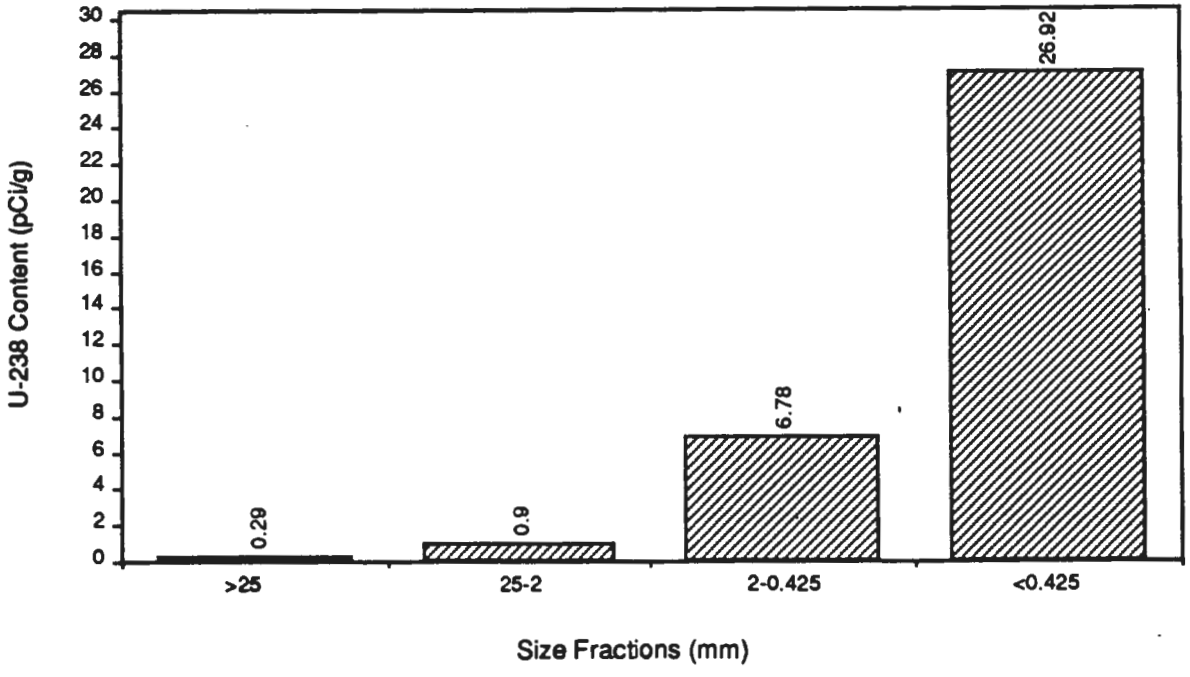


Figure 3-9b. Test #2, Contaminant Concentrations in Each Process Pile, ^{238}U Gamma Spectrometry.



GEN\M3.9

Figure 3-10a. Test #2, Wet-Sieved Size Distribution of Processed Soils, ^{235}U Gamma Spectrometry. (Serne et al. 1993).

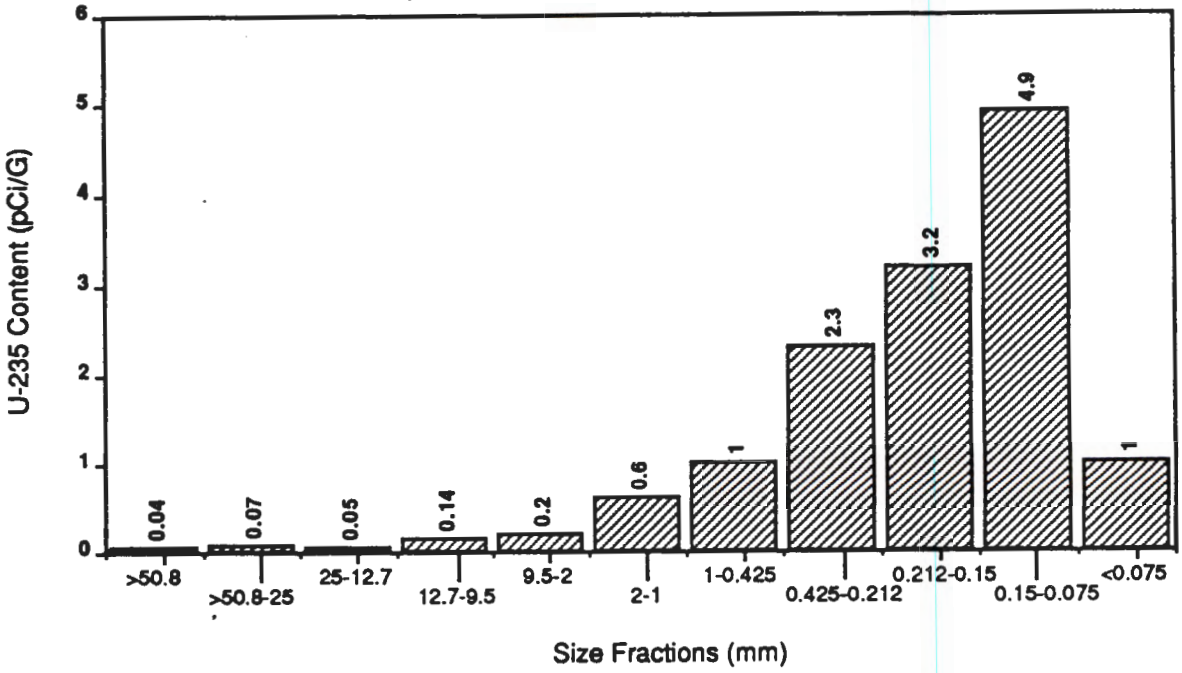


Figure 3-10b. Test #2, Contaminant Concentrations in Each Process Pile, ^{235}U Gamma Spectrometry.

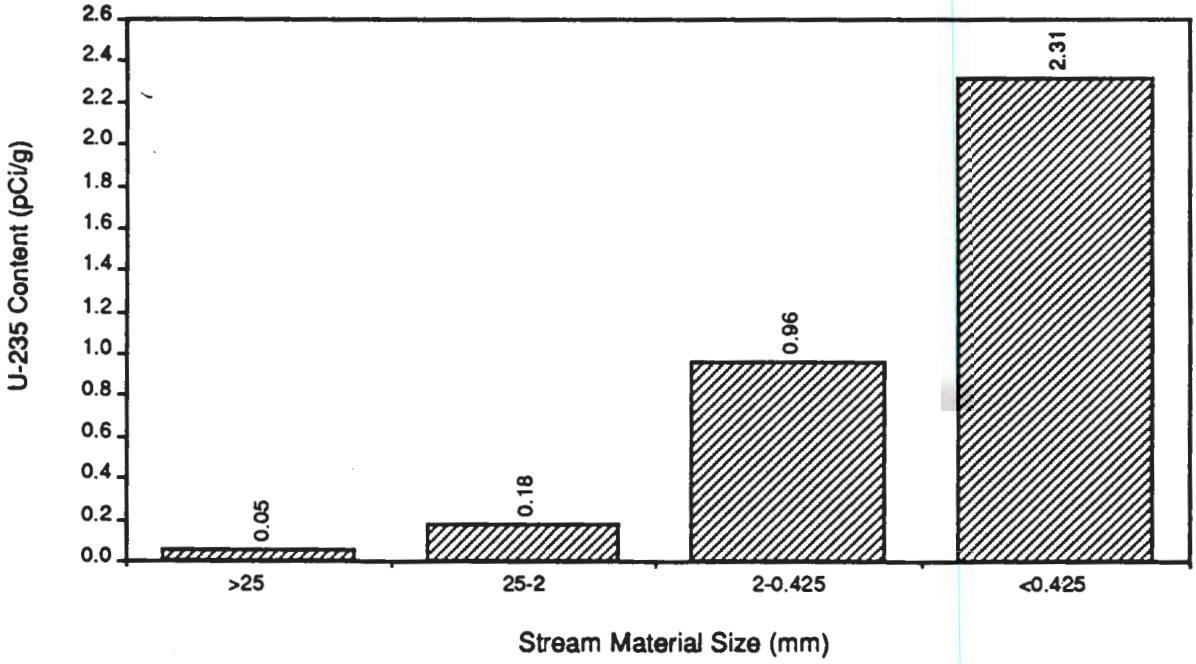


Figure 3-11a. Test #2, Wet-Sieved Size Distribution of Processed Soils, ^{60}Co Gamma Spectrometry. (Serne et al. 1993)

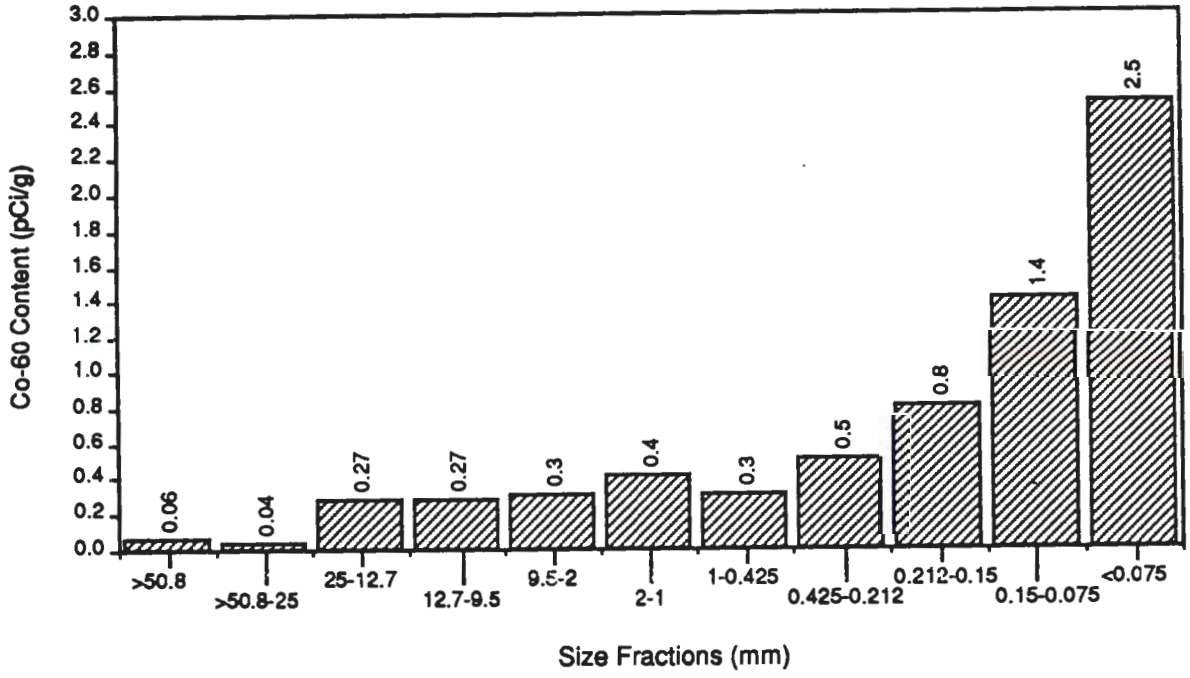
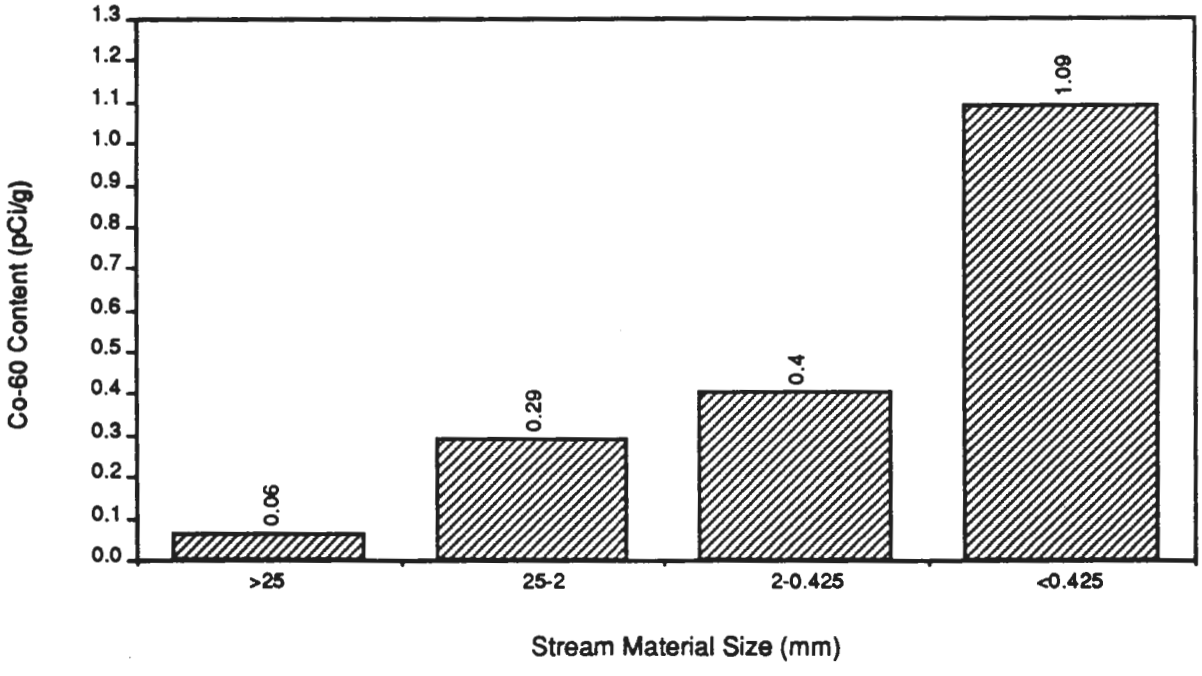


Figure 3-11b. Test #2, Contaminant Concentrations in Each Process Pile, ^{60}Co Gamma Spectrometry.



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processing, no "green" particles were detected in the trommel oversize material as in the first run. This could be for one of two reasons: (1) the increased trommel speed did break down the larger particles more than in Test #1, or (2) feed came from a different source in which there were no larger particles of the "green material."

The 2-mm to 0.425-mm material was unchanged. It still visibly contained particles of the "green material," and activity levels of approximately 400 counts per minute were measured in the field. The 0.425-mm screen was sprayed with water from a garden hose in a further attempt to break down the green particles. The added sprays washed the soils more effectively as they traveled across the screen but didn't seem to reduce or break down the "green material." This run provided additional evidence that the system does not have enough energy to break down the "green material," and an attrition scrubber is required. Results from Test #1 showed that an attrition scrubber would break down the material (likely the "green material") so that fine particles (<0.75 mm) increased and the remaining larger material exhibited significantly lower activity.

Approximately 5 tons of soil was processed in this run. Only field measurements were made; no samples were taken.

3.4 WATER TREATMENT RESULTS

Preoperational testing of the water treatment unit was performed during the month of September to ensure that all equipment was operating appropriately. Minor modifications/repairs were made based upon this test. The clarification portion of the system was then transported to the North Process Pond and prepared for testing on the soil-washing wastewater during the week of September 20, 1993. Actual testing did not begin until the first week of November.

Initial testing began by processing the wastewater at 35 gal/min. At this flow rate, ferric chloride was added to the wastewater at a rate of 35 mg FeCl/L of water. This was added to the waste stream in the flash mix tank. Next, a cationic polymer was added to the stream leaving the mix tank at a rate of 2 mg/L of water.

The first day of operation consisted primarily of filling the clarification system and establishing constant flow conditions. A set of analytical samples was taken prior to turning the system off for the night. Results of these samples have not yet been obtained. Field screening analysis including total suspended solids and turbidity were performed. Analytical samples were typically taken once operational conditions were stabilized. Several samples were also sent to an onsite laboratory for a limited analytes analysis. Available results are presented in Table 3-17.

Field measurements from the first two days of sampling indicate that the flocculation process was working. Mechanical difficulties were encountered making it difficult to optimize the flocculation process. These mechanical difficulties resulted in two weeks of down time. Once replacement parts were

Table 3-17. Water Treatment Samples and Analyses as of December 1, 1993.*

DATE	FIELD SAMPLES			ANALYTICAL SAMPLES									
	SAMPLE TYPE	TURBIDITY NTUs	TSS mg/l	HEIS #	SAMPLE TYPE	Mg mg/L	Al mg/L	Cr mg/L	Cu mg/L	Sr mg/L	Zr mg/L	Ba mg/L	U-238 mg/L
11/04/93	Influent	1.9		B09BR6	Influent								
	Effluent	19.6		B09BR7	Effluent								
	Clarifier Solids	976	822	B09BR8	Influent								
	Influent	17.5	10	B09BR9	Effluent								
	Effluent	10.6	24	B09BW5	Trip Blank								
	Clarifier Solids	970-1000	980	B09BW6	Influent-PNL	5.21	NA	.00108	.0137	.0934	.00191	.0771	1.9
	Influent	4.96	17	B09BW7	Effluent-PNL	5.24	.288	.022	.284	.0949	.0195	.0834	4.18
	Effluent	6.2	9	B09BW8	Trip Blank								
				B09BW9	Influent-PNL	3.33	.0822	.00196	.0102	.051	.00367	.0385	2.84
				B09BX0	Effluent-PNL	4.49	.093	.00344	.0505	.0793	.003	.0662	1.42
				B09BX1	Effluent Dup-PNL	4.53	.0482	.00247	.0363	.0774	.0164	.0659	1.10
				B09BS0	Effluent Dup								
11/05/93				B09BX2	Sludge-PNL	13.3	15.5	.0821	.308	.124	1.26	.419	114
11/16/93	Influent	6.22	4.0	B09BX3	Influent Filtered-PNL	3.84	0.0007	0.0015	0.0055	0.081	0.0003	0.12	0.033
	Influent	11.4	7.0	B09BX4	Influent-PNL	3.86	0.111	0.0057	0.030	0.077	0.0032	0.106	1.66
	Effluent-filtered	0.32	0.0	B09BX5	Effluent Filtered-PNL	3.86	0.011	0.0012	0.0086	0.076	0.0002	0.126	0.063
	Influent	14.3	9.0										
	Effluent	20.3	12.0										

* Blank spaces are analyses that have not been completed

installed, system operations were reinitiated. At this time, the outside temperature was dropping below 32° F during the nighttime hours. Several attempts were made to continue operations, but the effectiveness of the ferric chloride diminishes drastically at these lower temperatures. As a result of these freezing temperatures, it was decided to drain the system for the winter.

Several bench-scale tests were performed during the operation of the system in an attempt to optimize the process chemistry. The results of these tests indicate that controlling the amount of ferric chloride is crucial. If more than twice the concentration is added, no settling will occur. The volume of cationic polymer added is not as crucial, however. Large overdoses of polymer only slow the rate of floc formation and settling.

Resumed testing is planned for mid-March once freezing conditions have passed. Based on the preliminary analytical results from the tests completed to date (analytical results obtained for sample numbers B09BX3, B09BX4 and B09BX5 indicate that the bulk of the uranium was removed from the water during the treatment process), the optimization of the flocculation process should be successful in treatment of the water.

3.5 COMPARISONS WITH POTENTIAL ARARS

Some potential ARARs for cleanup include the following:

- EPA proposed health-based standards (Subpart S)
- dangerous waste designation limits
- land disposal restrictions
- MTCA residential standards
- residual radioactivity levels
- groundwater cleanup limits
- drinking water standards
- ambient water quality criteria for freshwater chronic toxicity.

Comparisons of a few potential ARARs with test results and performance levels are given in Table 3-18. Water-based standards are significantly lower for all of the constituents shown.

3.6 DEVIATIONS FROM THE TEST PLAN

Many of the deviations from the test plan were discussed with RL, EPA, and Ecology, and verbal approval was given to proceed prior to implementing changes. These changes and other field changes agreed to by the field team leader and project engineer are identified in this section.

Deviations to the test plan included the following:

- In Tests #1 and #2 about half the material discussed in the test plan was processed. This was due to two factors. First, the system used was designed and built under a very tight schedule and only available equipment could be used; consequently, there were many breakdowns and

Table 3-18. Test Performance Levels and Comparisons for ^{238}U, ^{235}U, ^{60}Co, Cu and Cr.

Constituent	Test #1 pCi/g	TEST #2 pCi/g	Test Plan Rev. 0	Test Plan Rev. 1	MTCA, residential standards	RESRAD in Test Plan Rev. 0	10 E-6 Cancer Risk
^{238}U	69.5[1] pCi/g	6.8[2] pCi/g	50 pCi/g	370 pCi/g	NA	426 pCi/g	250 pCi/g
^{235}U	8.6[1] pCi/g	1.0[2] pCi/g	15 pCi/g	170 pCi/g	NA	142 pCi/g	430 pCi/g
^{60}Co	3.2[1] pCi/g	0.4[2] pCi/g	1 pCi/g	7.1 pCi/g	NA	7.0 pCi/g	460 pCi/g
Cr[3]*	122	18.8	1,600 mg/kg	1,600 mg/kg	80**	NA	8.5*
Be[3]	0.04	0.35	172 mg/kg	172 mg/kg	0.2**	NA	2.9

1. The concentration of constituents after attrition scrubbing in the 0.425 to 2 mm process pile.
2. The concentration of constituents in the field in the 0.425 to 2 mm feed pile.
3. Values are analyses from off-site laboratories in the 0.425 to 2 mm process pile.

NA=Not Applicable
* Chromium UI using the inhalation pathway. Chromium is not a cancer risk under the ingestion pathway.
**Chromium is chromium UI (80 mg/kg)

delays resulting in the processing of less material. Second, in Test #1 it was obvious early on from field measurements that radioactivity was present in each of the processed piles of soil; consequently, nothing would have been gained by processing more material.

- "Green Material" was processed in Test #1, while the test plan states that it would not be processed. Reasons for this were given in Section 2.2.2.

- The test plan schedule shows that Test #1 would be performed the first 2 weeks of June and Test #2 the last 2 weeks. Due to additional testing and analyses of the "green material" and significant modifications to equipment, Test #2 was not completed until September.

- Laboratory attrition scrubbing tests were not identified in the test plan. These were necessary because the trommel and screens did not adequately break down material in Test #2. Laboratory attrition tests were conducted in accordance with *100 Area Soil Washing Bench-Scale Test Procedures* (Freeman et al. 1993).

- Sample numbers and times for the runs varied from the test plan. Fewer effluent samples were taken during each run because of shorter processing periods. Also, two sets of samples were collected during the June run since the second run was originally intended to serve as Test #2. Additional samples were collected from the 0.425-mm to 2-mm and 2-mm to 25-mm process piles after a final short run in June. These samples were sent to PNL for screening analyses. A set of soil and water samples was collected after Test #2 in the September run, and field screening measurements were made on soils containing the "green material" that were processed in September.

- The 0.425-mm screen was used in Test #2 as opposed to the 0.210-mm screen, and feed soils were obtained from new locations in the North Process Pond in order to avoid the "green material." Reasons for these changes are discussed in Section 2.2.3.

4.0 COST

4.1 INTRODUCTION

This section looks at the potential costs that might be expected for a full-scale operation. These estimates were based on knowledge gained during this test and address only the operating costs.

The following assumptions were made regarding full-scale operation:

- Processing rate is 100 tons/hr.
- Single shift of processing/day.
- Hours of processing/shift is 5 hr.
- Number of processing days/year is 250 days.
- All preventative maintenance occurs during an off shift.
- Fresh water to feed the plant and for dust control will be supplied by pipeline.
- Electrical power will be supplied by lines.
- Numerous samples will be taken during the shift for field screening to control the process.
- Two additional samples will be taken every process day (one for clean material, one for waste material). The clean samples will be composited for one week to make one sample, which will be analyzed using EPA Level III and Level V analytical methods (EPA 1990). The same will be done with the waste sample.
- 20% of the samples receiving EPA Level III analysis will be validated (the number validated for 300-FF-1 characterization work).
- When feasible, work will be performed by onsite employees.

Five factors were looked at in developing these costs. They were labor, materials and consumables, utilities, analytical costs, and maintenance costs. Overhead costs are not included. Each of the five factors is discussed in detail in the following sections. In addition, a 20% contingency was added.

4.2 LABOR

Labor is composed of two groups: those directly involved with the operation of the plant and the support labor necessary for the day-to-day operation. Table 4-1 details the expected direct labor personnel requirements, and Table 4-2 details the anticipated requirements for support labor.

Table 4-1. Direct Labor Requirements.

Personnel	*FTEs	Annual Cost per FTE	Total Annual Cost
Plant Operators	2	$65,000	$130,000
Equipment Operators	3	$65,000	$195,000
Sampler/Lab. Tech.	3	$65,000	$195,000
Supervisor	1	$65,000	$65,000
TOTAL DIRECT LABOR	9		$585,000

*FTE - Full Time Employee

Table 4-2. Support Labor Costs.

Personnel	FTE's	Annual Cost per FTE	Total Annual Cost
Health Physics Tech.	2	$65,000	$130,000
Site Safety Officer	1	$65,000	$65,000
Maintenance	2	$65,000	$130,000
Fuel Truck Driver	0.5	$65,000	$33,000
TOTAL SUPPORT LABOR	5.5		$358,000

It is anticipated that full-scale operation will require two full-time plant operators. During the test, three people were required to oversee the operation; however, it is anticipated that the full-scale plant would be more automated and only require two operators.

Three equipment operators will be necessary to perform the material handling. Two people will be involved in feeding the plant (one dozer and one loader) and one loader operator will handle the processed streams coming out of the plant.

Three people will take samples of the process streams and do field screening tests (XRF and gamma scans) for process control.

There will be one full-time supervisor/engineer for the operation.

It is expected that two Health Physics Technicians will be required during the operation. Two were necessary for the test and two should be adequate for the full-scale operation.

One Site Safety person will be sufficient for the operation. One person was adequate to cover the test.

Two maintenance people will be required to perform preventative maintenance on the plant and the equipment when they are shut down. These two maintenance FTEs will also cover any electrical work required. The fuel truck driver is included to fuel the equipment and to serve as a third maintenance person.

4.3 MATERIALS AND CONSUMABLES

This section estimates the amount of materials and consumables that will be used by a full-scale operation. Table 4-3 details the items considered in this section.

Table 4-3. Materials and Consumables Costs.

Item	Total Annual Cost
Water for make-up and dust control	$7,000
Water treatment flocculents	$62,000
Laundry	$66,000
Safety equipment and supplies	$5,000
Signs, ropes, fences, etc.	$5,000
Dust control equipment and supplies	$5,000
Tools	$1,000
Garbage	$5,000
Miscellaneous materials (steel, timber, etc.)	$10,000
TOTAL MATERIALS AND CONSUMABLES	$161,000

It is estimated that a full-scale plant that recycles its water will require 265 L/min to feed the system. This is based on the amount of water lost to the various piles during the test and adjusted for a 100 ton/hr system. It is substantiated by the fact that during a visit to see the soil-washing plant at the King of Prussia site in New Jersey, site personnel stated that their 25 ton/hr plant required approximately 76 L/min of feed water.

Based on the work done during the test, it is estimated that approximately 189 L/ton of material processed will be required for dust control. Some of

this water goes on the material to be washed and some goes onto the roadway where the equipment is traveling. That amounts to 314 L/min for dust control.

Total water required to feed the plant would be 579 L/min. This amounts to 42.58 million L/yr and will cost about $7,000 at City of Richland water costs.

The estimates used to establish the baseline operating parameters for the water treatment system processing the water from the test give a cost of approximately $0.50/ton of material processed for flocculents to treat water.

Laundry will cost approximately $6/person to dress out one time ($2/lb, 3 lb/set of whites). There are 14.5 FTEs, but not all will dress out every day. Assuming that an average of 11 dress out 4 times per day for 250 days, that amounts to 11,000 sets/yr or $66,000/yr for laundry.

An estimate of $5,000/yr was made for safety equipment and supplies. This covers ear plugs, safety glasses, hard hats, face shields, plastic pants and coats, safety harnesses, instruments required by the Site Safety Officer, first aid kits, eye wash units, showers, etc.

A total of $5,000/yr was included for signs, ropes and fences. This may be higher for the first year and less after that, but $5,000/yr is estimated.

For dust control, a sprinkler system would be set up to pre-wet the excavation area and roadways prior to the beginning of work. A total of $5,000 was included to cover this simple system, which would lay on top of the ground.

Garbage is estimated to be $5,000/yr.

In order for the operators to make adjustments to the equipment from time to time and to clean the equipment as required, a set of tools will be required. A total of $1,000 is included.

As is the case with any operation, there are numerous miscellaneous items that are not covered elsewhere. Therefore, $10,000 has been included here for those items.

4.4 UTILITIES

This section addresses the costs related to the utilities that will be needed during full-scale operation. Table 4-4 details these costs.

It is estimated that a full-scale system based on the plant utilized for the test could require 260 kW in various motors. These would include conveyors, vibrating screens, pumps, trommels, autogenous grinders, attrition scrubbers, etc. The total estimated power required would be 260 kW/hr for 7 hr/day with a demand of approximately 260 kW for any 15-minute period. A figure of $0.035/kW-hr is used for the usage cost plus $5,000 additional for the demand cost for a total of $21,000/yr.

Table 4-4. Utility Costs.

Item	Total Annual Cost
Electricity	$21,000
Diesel Fuel	$31,000
Gasoline	$2,000
TOTAL UTILITY COSTS	$54,000

Diesel consumption for two front-end loaders and a dozer is estimated to be 114 L/hr of operation based on tables from the Caterpillar (a trademark of Caterpillar, Inc.) Performance Handbook 22 Edition. A cost of $0.22/L for diesel was used. Gasoline is a minor cost for pickups, and a total cost for fuel of $2,000/yr is estimated.

4.5 ANALYTICAL COSTS

Analytical costs associated with a full-scale operation are assessed in this section. Table 4-5 details these costs.

Table 4-5. Analytical Costs.

Item	Total Annual Cost
Analysis	$130,000
Sampling equipment and supplies	$15,000
Data validation	$26,000
TOTAL ANALYTICAL COSTS	$171,000

Analytical costs are based on the costs incurred under the contracts that were used for the test. The total cost for analysis with expedited turnaround time was approximately $1,300/sample. The total cost for two samples/week comes to $130,000/yr.

Sampling equipment and supplies will also include field screening equipment such as an X-ray fluorescence analyzer, hand-held gamma detectors, bottles, spoons, coolers, ice, etc. This cost will likely be high during the first year and much less the following years. An average cost of $15,000/yr is estimated.

Data validation costs are difficult to predict dependent on what is required but could cost as much per sample as the analysis itself. Using this as a conservative number and assuming that 20% of the data will require validation, a total cost of $26,000/yr would be incurred.

4.6 MAINTENANCE COSTS

This section discusses the maintenance costs anticipated for a full-scale operation. Table 4-6 details these costs.

Table 4-6. Maintenance Costs.

Item	Total Annual Cost
Parts	$100,000
Tools	$1000
Miscellaneous (lubricants, solvents, rags, etc.)	$20,000
TOTAL MAINTENANCE COSTS	$121,000

Parts for this cost analysis include conveyor belts, loader tires, replacement screens, belts, filters, hoses, pump impellers and all other miscellaneous parts that will be required to operate and maintain the plant and associated equipment. This cost is strictly an estimate, since the test did not last long enough to establish any baseline numbers. A figure of $100,000/yr will be used.

A figure of $1,000/yr is included for tools. This is in addition to the $1,000/yr for tools for the operators.

Another miscellaneous category includes lubricants and solvents. An estimate of $20,000/yr is used.

4.7 COST SUMMARY

Combining individual costs, the entire cost for operating a full-scale plant was determined. Table 4-7 shows a summary of this.

Table 4-7. Full-Scale Operation Cost Summary.

Item	Total Annual Cost	Total Cost Per Ton Processed
Labor-direct	$585,000	$4.68
Labor-support	$358,000	$2.86
Materials and consumables	$161,000	$1.29
Utilities	$54,000	$0.43
Analytical	$171,000	$1.37
Maintenance	$121,000	$0.97
	$1,450,000	$11.60
Contingency (20%)	$290,000	$2.32
Total operating costs	$1,740,000	$13.92

As can be seen from the costs in Table 4-7, the anticipated operating cost for the full-scale soil-washing plant is $13.92/ton of material processed. This is believed to be a conservatively high cost based on the assumptions made and added contingencies. It is also anticipated that this cost could be reduced by increasing the processing rate, increasing the number of days of operation, and/or increasing the number of shifts worked per day.

It should be noted that there are additional costs for a project that are not included in the operating costs. These include the capital costs involved with the purchase, mobilization, and construction of the plant; the cost for installation of electrical lines and water lines; costs associated with hauling and disposal of process wastes; and overhead costs for various organizations involved. These items will need to be assessed in comparing soil washing with other remedial alternatives.

One of the benefits of performing the vendor test, in addition to the tests reported, is to obtain better cost and scale-up information from a better engineered field-scale system. As noted previously, the system used for tests in this report was made up of equipment components that were available at the time and were not necessarily designed to work together.

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5.0 CONCLUSIONS AND RECOMMENDATIONS

The overall objective of the test was to evaluate the use of physical separations systems as a means of concentrating chemical and radiochemical contaminants into fine soil fractions, thereby minimizing waste volumes. The minimum test performance levels are shown in Table 1-1. The goal for the test was to achieve a 90% (by weight) reduction in contaminated soils. Radioactive performance levels were the minimum of the following:

- <20 μR/hr above background radioactivity (DOE 1990)
- The Residual Radioactivity Program, Version 4.0, <25 mRem/hr
- WHC radioactive threshold concentrations for accessible soils (WHC 1991)

The RI report, analyses by Serne et al. (1992), and this treatability test showed that the primary risk driver in the 300-FF-1 OU is uranium (^{238}U and ^{235}U). Analytical data presented in Section 3.0 showed that all other contaminants in soils were below test performance levels prior to processing. These performance levels were established as goals for the test, They are not soil cleanup standards. Final cleanup standards for 300-FF-1 soils have yet to be determined but are critical to assessing the effectiveness of remedial alternatives.

In general, the physical separation system tested met the test goals, thereby demonstrating the potential to reduce the amount of contaminated soils in the 300-FF-1 OU.

In Test #2, offsite analytical results of soil piles after processing showed that soils representative of the largest fraction of the 300-FF-1 OU Waste Sites (not containing "green material") were separated so that the concentration of uranium was significantly lower in the coarse fraction of soils (12 pCi/g for >0.425-mm particles and 93.63 pCi/g for <0.425-mm particles). PNL analyses showed similar results. These levels are significantly lower than test performance levels of 370 pCi/g for ^{238}U and 170 pCi/g for ^{235}U, and lower than many of the potential ARARs and comparison levels discussed in Section 3.5. At a cut point of 0.425 mm, this would result in a 98.6% by weight reduction in the amount of contaminated feed material.

While physical separation processes were effective for these soils, it is recommended that careful consideration be given in the Phase III Feasibility Study as to the benefit versus cost of processing soils within the 300-FF-1 OU that are near background levels and below test performance levels prior to processing.

Test #1 showed that soils containing the "green material" can likely be processed with the addition of an attrition scrubber to the system tested. This finding exceeded the scope of the test plan, which originally excluded processing of soils containing the "green material" due to laboratory indications that physical separation processes may not be effective for this material (Dennison et al. 1989).

After processing, radioactivity was measured in the field in each of the process piles. Analytical tests confirmed that, as expected, the "green material" was the primary source of the radioactivity and that ^{238}U was the primary radioactive isotope. However, after wet sieving in the laboratory, "green material" was broken down so that gamma spectrometry analyses showed that soils met performance levels for 94% by weight of the feed soils (>0.15 mm).

Laboratory tests also showed that a process with higher energy imparted directly to the particles (i.e., attrition scrubbing) would further break down particles containing the "green material" so that soils >0.075 mm would meet test performance levels and the radioactivity of soil particles >0.425 mm would be significantly lower than with wet sieving only (see Section 3.3). A disadvantage of attrition scrubbing is that of the material scrubbed, as much as 10% to 12% more fines were generated (see Table 3-10). This resulted in an additional 4% to 5% more contaminated soil or approximately an 85% by weight net reduction in the amount of contaminated soil (Section 3.2.2). A cut point of 0.425 mm would result in less reduction of contaminated soils, but the highest concentrations of ^{238}U and ^{235}U in coarse soil fractions would be <50 pCi/g and <5 pCi/g respectively.

It is recommended that an attrition scrubber be used to process soils containing "green material," and that additional field-scale tests be performed using the scrubber. An attrition scrubber has been purchased to conduct these tests.

Cost estimates (Section 4.0) for a full-scale physical separations system to operate at 100 ton/hr were approximately $14/ton of material. This figure is for operating costs only. It does not include overhead costs or capital costs for equipment and mobilization. Capital costs among vendors range from roughly $1,000,000 to over $5,000,000.

Information regarding water treatment needs and the effectiveness of the water treatment system is scheduled to be tested and will be incorporated in a later draft. Results of the vendor test are also scheduled and will be included in a later revision to this document.

The water treatment test and vendor test are tentatively scheduled to be completed in the spring of 1994 in order to revise this report and incorporate findings in the Phase III Feasibility Study to be completed by August 1994. A detailed schedule for additional tests and a revision to the RI Phase II report are not included because the schedule is dependent on vendor contract modifications, approval of the vendor's system, cold weather conditions, and the priority of equipment and personnel for these tests and other Environmental Restoration programs and Tri-Party Agreement milestones.

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APPENDIX A

PURGEWATER ACCEPTANCE STANDARDS

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Table A.1. Purgewater Acceptance Standards[a]

Analyte	Units	Concentration
Metals (inorganics)[a]	ppb	
Aluminum		NA
Antimony		16,000
Arsenic		480
Beryllium		53
Cadmium		11
Chromium		110
Copper		120
Iron		3,000
Lead		32
Manganese		500
Mercury		0.1
Nickel		1,600
Silver		10
Uranium		590
Zinc		1100
Organics[a]	ppb	
1,2-dichloroethylene		70
Methylene chloride		N/A
Tetrachloroethylene		8,400
Trichloroethylene		50
PCB	ppb	
Radiochemical Contaminants[b]	pCi/L	
Cesium-137		2000
Cobalt-60		1000
Uranium		400

[a] Values are from Westinghouse Hanford Company Environmental Compliance Manual, Section 8, "Water Quality" (WHC 1993).

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APPENDIX B

ANALYTICAL DATA

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B.1 ANALYTICAL DATA FOR TEST #1

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DATA QUALIFIERS FOR ANALYTICAL DATA

U Indicates that this constituent was analyzed for but undetected.

L Indicates the value is less than the Contract Required Detection Limit (CRDL) and above the Method Detection Limit (MDL).

Q Data can be used qualitatively, but regulatory decisions should not be made on a single flagged data point.

H Indicates holding time missed. Data can be used qualitatively, but regulatory decisions should not be made on a single flagged data point.

XYZ indicates matrix interference was encountered causing higher detection limits and false results in the gamma scan analysis.

TEST #1 SOIL WASHING RESULTS
RAW FEED MATERIAL

	JUNE 1993 PROCESSING						
	B07C09 soil mg/kg	B07C10 soil mg/kg	B07C11 soil mg/kg	B07C67 soil mg/kg	B07C38 soil mg/kg	B07C39 soil mg/kg	B07C40 soil mg/kg
Ag	67	29	9.6	9.4	8.7	18	5.1
Al	31000	22000	19000	18000	24000	22000	22000
As	3.8	2	1.7	1.7	1.9	1.5	2.7
Ba	270	700	1300 Q	570 Q	1600	1200	1800
Be	0.75	0.93	U	U	U	1.5	U
Ca	17000	12000	9600	8000	10000	11000	10000
Cd	1.7	U	0.52L	U	0.51L	U	U
Co	6.1	6.4	6.9	7.2	7.3	7.1	7.2
Cr	520	280	160 Q	100 Q	150	220	140
Cu	10000	3500	910 Q	1200 Q	930	2300	300
Fe	14000	16000	18000	17000	18000	18000	17000
Hg	3.1	2.9	1.9	1.2	2.5	2.6	2.2
K	540	980	1200	1300	1300	900	1100
Mg	8000	6600	5700	5400	6300	6300	6400
Mn	250	260	260	270	250	240	240
Na	1000	1600	2100	1900	2800	2100	2800
Ni	940	380	110	130	99	240	45
Pb	83	40	36	29	60	49	38
Sb	12L	7.4L	10LQ	6.9LQ	U	5.2L	U
Sn	41	25	20 Q	UQ	20	18	25
V	34	35	37	45	38	36	35
Zn	150	95	75	56	77	85	69
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0.0715 XYZ	0.0671 XYZ	0.0298 XYZ	0 XYZ	0 XYZ	0.0408 XYZ	0.062 XYZ
Cs-137	0.129 XYZ	0.144 XYZ	0.14 QXYZ	0.18 QXYZ	0.264 XYZ	0.272 XYZ	0.181 XYZ
Pb-212	1.84 XYZ	1.32 XYZ	0.89 QXYZ	1.38 QXYZ	0.817 XYZ	1.53 XYZ	1.81 XYZ
Pb-214	0.38 XYZ	0.604 XYZ	0.528 XYZ	0.57 XYZ	0.586 XYZ	0.547 XYZ	0.509 XYZ
Ra-224	0.347 XYZ	0.591 XYZ	0.48 QXYZ	1.4 QXYZ	0.42 XYZ	0.615 XYZ	0.522 XYZ
Ra-226	1.87 XYZ	1.34 XYZ	0.904 XYZ	0.535 XYZ	0.83 XYZ	1.55 XYZ	1.84 XYZ
Ru-106	0.0687 XYZ	0 XYZ	0 XYZ	0 XYZ	0.182 XYZ	0.25 XYZ	0.08 XYZ
Sb-125	0 XYZ	0.0178 XYZ	0.0087 XYZ	0 XYZ	0 XYZ	0.1 XYZ	0.157 XYZ
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	3360	2220	2650 Q	663 Q	1280	775	1670

U-Analyzed for but undetected
Q=Can be used qualitatively
L=Less than CRDL and above MDL
XYZ=Matrix interference encountered

TEST #1 SOIL WASHING RESULTS FRESH WATER (UNFILTERED)			
	JUNE 1993 PROCESSING		
	B07C70 water mg/L	B07C71 water mg/L	B07C72 water mg/L
Ag	U	U	U
Al	0.19 L	0.12 L	0.13 L
As	U	U	U
Ba	0.026	0.026	0.026
Be	U	U	U
Ca	20	17	17
Cd	U	U	U
Co	U	U	U
Cr	U	U	U
Cu	0.0068 L	0.0063 L	0.0073 L
Fe	0.46	0.4	0.39
Hg	U	U	U
K	1.2	0.75 L	0.81 L
Mg	4.6	3.9	4
Mn	0.013	0.011	0.011
Na	3.2	2.6	2.6
Ni	U	U	U
Pb	0.002 L	0.0072	0.0069
Sb	U	U	U
Sn	U	U	U
V	0.0047 L	U	U
Zn	0.0058 L	0.0045 L	0.0055 L
	pCi/L	pCi/L	pCi/L
Co-60	7.6	9.76	1.91
Cs-137	2.01	0.433	4.87
Pb-212			
Pb-214			
Ra-224			
Ra-226			
Ru-106	11	12.3	0
Sb-125	0	0	0
	ug/L	ug/L	ug/L
U-Nat	0.28	1.18	0.339

U=Analyzed for but undetected L=Less than CRDL and above MDL

TEST #1 SOIL WASHING RESULTS
25 mm TO 2mm (June 1993 Processing) (sheet 1 of 2)

	B07C14 soil mg/kg	B07C15 soil mg/kg	B07C16 soil mg/kg	B07C17 soil mg/kg	B07C18 soil mg/kg	B07C19 soil mg/kg	B07C20 soil mg/kg	B07C21 soil mg/kg	B07C22 soil mg/kg	B07C23 soil mg/kg	B07C24 soil mg/kg	B07C25 soil mg/kg	B07C43 soil mg/kg	B07C44 soil mg/kg	B07C45 soil mg/kg	B07C46 soil mg/kg
Ag	5.4	8.1	5.1	5.5	2.5	4.8	4.3	11	0.99 L	1.7	0.58 L	4.7	13	3.1	U	17
Al	21000	31000	8500	5800	3700	11000	6900	13000	3900	4900 L	4400	12000	15000	22000	4000	20000
As	1.5	0.9	0.64	0.2 L	0.58	0.65	1	0.81	0.98	0.59	0.64	0.96	3.5	1.1	U	2.5
Ba	100	160	110	79	60	200	110	170	170	100	80	90	180	70	61	200
Be	U	0.52	U	0.2	0.15 L	0	U	U	U	U	0.14 L	U	0.79	0.32	U	1
Ca	5900	8700	6700	3600	4100	6600	6200	7600	4100	5000	1500	6100	8500	4100	1000	11000
Cd	U	U	U	U	U	U	U	0.73 L	U	U	0.35 L	U	U	U	0.39 L	0.65 L
Co	7.7	9.8	8.7	2.3	5.9	9.8	8.5	6.6	5.7	8.2	4.5	8.1	10	2.9	2.7	8.1
Cr	59	100	58	58	23	36	50	140	20	20	17	62	150	32	5.2	170
Cu	1300	2100	1200	1200	320	650	1100	2600	280	370	130	1300	3300	770	61	4400
Fe	20000	23000	21000	8500	13000	25000	26000	17000	16000	22000	7500	20000	26000	7400	5000	19000
Hg	0.37 L	1.5	0.08 L	1.5	0.39 L	0.1 L	0.3 L	0.1 L	U	0.37 L	0.41	2.2	0.89	0.42	1.7	2.6
K	360	410	630	210	340	440	660	380	480	440	1500	460	410	200	650	620
Mg	3700	4500	4500	1800	2200	4500	4200	4000	2500	3800	3900	4000	7500	1800	2100	6100
Mn	210	290	240	95	320	340	410	200	170	250	87	260	310	74	71	280
Na	750	1000	780	370	430	840	860	780	410	680	240	710	850	650	720	1300
Ni	92	180	100	100	34	57	80	230	31	35	14	95	250	52	12	300
Pb	7	7.2	15	4.5	11	12	13	22	19	13	8	12	60	20	16	42
Sb	5.5 L	U	U	U	U	U	U	U	U	U	U	U	U	8.3 L	U	U
Sn	U	15	U	U	6.7 L	U	U	6.6	5.9 L	U	U	U	5.7	10	0	6.8
V	59	76	54	27	34	55	48	45	48	71	18	50	61	20	20	49
Zn	52	85	62	33	33	58	49	74	41	46	16	56	93	27	6	

TEST #1 SOIL WASHING RESULTS (25 mm to 2 mm (June 1993 Processing) (Sheet 2 of 2)

	B07C14	B07C15	B07C16	B07C17	B07C18	B07C19	B07C20	B07C21	B07C22	B07C23	B07C24	B07C25	B07C43	B07C44	B07C45	B07C46
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0.0245 XYZ	0.013 XYZ	0.029 XYZ	0.031 XYZ	0.032 XYZ	0.003 XYZ	0.035 XYZ	0 XYZ	0 XYZ	0.009 XYZ	0 XYZ	0.003 XYZ	0.009 XYZ	0.025 XYZ	0.044 XYZ	0.064 XYZ
Cs-137	0.0724 XYZ	0.03 XYZ	0.036 XYZ	0.034 XYZ	0.049 XYZ	0.039 XYZ	0.057 XYZ	0.082 XYZ	0.103 XYZ	0.056 XYZ	0.043 XYZ	0.034 XYZ	0.084 XYZ	0.106 XYZ	0.124 XYZ	0.059 XYZ
Pb-212	0.811 XYZ	0.649 XYZ	0.886 XYZ	0.69 XYZ	0.824 XYZ	0.83 XYZ	0.687 XYZ	0.704 XYZ	0.896 XYZ	0.66 XYZ	0.622 XYZ	0.688 XYZ	1.34 XYZ	1.54 XYZ	1.42 XYZ	1.9 XYZ XYZXYZ
Pb-214	0.463 XYZ	0.497 XYZ	0.403 XYZ	0.375 XYZ	0.363 XYZ	0.521 XYZ	0.498 XYZ	0.399 XYZ	0.526 XYZ	0.43 XYZ	0.383 XYZ	0.465 XYZ	0.439 XYZ	0.455 XYZ	0.443 XYZ	0.445 XYZ
Ra-224	0.449 XYZ	0.498 XYZ	0.358 XYZ	0.475 XYZ	0.426 XYZ	0.42 XYZ	0.55 XYZ	0.344 XYZ	0.576 XYZ	0.392 XYZ	0.357 XYZ	0.408 XYZ	0.459 XYZ	0.455 XYZ	1.45 XYZ	1.94 XYZ
Ra-226	0.823 XYZ	0.659 XYZ	0.899 XYZXYZ	0.7 XYZ	0.836 XYZ	0.843 XYZ	0.698 XYZ	0.715 XYZ	0.91 XYZ	0.67 XYZ	0.632 XYZ	0.699 XYZ	1.36 XYZ	1.57 XYZ	0.39 XYZ	0.46 XYZ
Ru-106	0 XYZ	0 XYZ	0.08 XYZ	0.164 XYZ	0 XYZ	0 XYZ	0.167 XYZ	0.071 XYZ	0.225 XYZ	0.061 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ
Sb-125	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0.027 XYZ	0 XYZ	0.054 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0.042 XYZ	0.028 XYZ	0 XYZ	0 XYZ	0.027 XYZ
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	527	64.2	1820	1420	3870	272	61.3	111	185	272	131	1200	509	540	188	1480

U=Analyzed for but undetected
Q=Data can be used qualitatievely
XYZ=Matrix interference encountered

L=Less than CRDL and above MDL
H=Holding time missed

TEST #1 SOIL WASHING RESULTS
2mm TO 0.425mm

	JUNE 1993 PROCESSING											
	B07C26 soil mg/kg	B07C27 soil mg/kg	B07C28 soil mg/kg	B07C29 soil mg/kg	B07C30 soil mg/kg	B07C31 soil mg/kg	B07C32 soil mg/kg	B07C68 soil mg/kg	B07C55 soil mg/kg	B07C56 soil mg/kg	B07C57 soil mg/kg	B07C58 soil mg/kg
Ag	10	12	9.2	12	9.7	11	10	11	11	14	12	12
Al	17000	18000	13000	15000	14000	16000	14000	17000	17000	17000	16000	18000
As	1.4	1.6	0.94	0.87	1.5	2 Q	1.7	0.81 Q	1.8	1.4	1.8	1.5
Ba	300	340	360	460	280	370	380	330	470	470	570	480
Be	U	U	U	U	U	U	U	U	U	0.82	U	U
Ca	7000	7900	6200	8100	8500	8100	7100	8600	8400	10000	8300	9200
Cd	0.47 L	U	U	U	U	U	U	U	0.48 L	0.54 L	0.43 L	U
Co	6.6	5.9	5.9	7.6	6.1	6	6.9	7	5.9	7	6	5.5
Cr	120	120	97	140	99	110	110	110	130	160	130	140
Cu	1400	1400	1300	2200	1500	1600	1700	1700	2800	3200	2000	2700
Fe	18000	17000	17000	19000	18000	18000	18000	18000	16000	17000	15000	17000
Hg	1.1	0.97	0.83	0.79	0.96	0.96	1.4	1	1.1	1.8	1.4	1.8
K	720	790	660	690	760	850	690	870	700	750	780	800
Mg	5300	5000	4900	5500	5400	5300	5100	5500	5300	5900	5400	6100
Mn	260	240	210	240	310	240	230	270	220	240	200	230
Na	2000	1400	1000	1200	1200	1200	1100	1500	1200	1400	1300	1600
Ni	150	150	130	200	150	150	170	160	210	230	200	210
Pb	28	31	29	30	27	29	29	32	35	44	38	42
Sb	U	5.1 L	U	5.6 L	U	4.7 L	U	U	U	6.1 L	U	U
Sn	8.5 L	17	U	19	12	UQ	14	9.4 LQ	24	21	21	19
V	45	42	42	46	47	45	46	55	47	51	42	52
Zn	61	61	59	68	58	61	63	58	66	77	65	74
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0.0359 XYZ	0.0038 XYZ	0.0167 XYZ	0.0068 XYZ	0.0311 XYZ	0.05 XYZ	0.0092 XYZ	0.0277 XYZ	0.0593 XYZ	0.0409 XYZ	0.0482 XYZ	0.0704 XYZ
Cs-137	0.107 XYZ	0.102 XYZ	0.0861 XYZ	0.102 XYZ	0.117 XYZ	0.0791 XYZ	0.138 XYZ	0.0919 XYZ	0.0939 XYZ	0.101 XYZ	0.133 XYZ	0.0977 XYZ
Pb-212	0.858 XYZ	0.867 XYZ	0.843 XYZ	0.766 XYZ	0.806 XYZ	0.908 XYZ	0.703 XYZ	0.838 XYZ	1.5 XYZ	1.75 XYZ	1.22 XYZ	1.45 XYZ
Pb-214	0.494 XYZ	0.389 XYZ	0.328 XYZ	0.37 XYZ	0.407 XYZ	0.428 XYZ	0.395 XYZ	0.397 XYZ	0.4 XYZ	0.513 XYZ	0.426 XYZ	0.352 XYZ
Ra-224	0.341 XYZ	0.385 XYZ	0.394 XYZ	0.32 XYZ	0.539 XYZ	0.415 XYZ	0.254 XYZ	0.854 XYZ	1.53 XYZ	1.78 XYZ	1.24 XYZ	1.47 XYZ
Ra-226	0.872 XYZ	0.881 XYZ	0.857 XYZ	0.778 XYZ	0.82 XYZ	0.923 QXYZ	0.715 XYZ	0.329 QXYZ	0.202 XYZ	0.441 XYZ	0.46 XYZ	0.486 XYZ
Ru-106	0 XYZ	0 XYZ	0.0438 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0.232 XYZ	0 XYZ	0 XYZ	0 XYZ	0.354 XYZ
Sb-125	0.0529 XYZ	0.001 XYZ	0 XYZ	0.0268 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0.0521 XYZ	0.113 XYZ	0.0554 XYZ
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	403	144	809	593	564	516 Q	362	384 Q	1100	614	848	1460

U=Analyzed for but undetected
Q=Data can be used qualitatively
L=Less than CRDL and above MDL
XYZ=Matrix interference encountered

TEST #1 SOIL WASHING RESULTS
MINUS 0.425mm SLURRY WATER (UNFILTERED)

	JUNE 1993 PROCESSING						
	B07C75 water mg/L	B07C76 water mg/L	B07C77 water mg/L	B07C85 water mg/L	B07C79 water mg/L	B07C80 water mg/L	B07C81 water mg/L
Ag	0.05	1	0.53	0.98	0.64	0.3	0.18
Al	37	850	550	770	1000	480	250
As	0.003 L	0.024	0.028	0.026	0.023	0.022	0.011
Ba	2.1	67 Q	43	60 Q	120	59	27
Be	0.0013 L	0.019	0.011	0.018	0.018	0.0082	0.0042
Ca	19	400	170	400	350	170	100
Cd	U	0.011	U	0.0091 L	U	U	U
Co	0.0071 L	0.095	0.14	0.092	0.27	0.13	0.066
Cr	0.38	9.2	5.5	8.6	9.5	4.6	2.6
Cu	3.5	100	50	98	60	29	25
Fe	13	230	160	220	270	130	63
Hg	0.0045	0.13	0.078	0.14	0.12	0.096	0.049
K	3.5	34	24	33	37	18	9.2
Mg	10	190	120	170	210	100	59
Mn	0.27	5.3	3.7	4.9	6	2.9	1.6
Na	31	120	110	120	170	96	66
Ni	0.32	10	5	9.6	5.3	2.7	2
Pb	0.093	2.6	1.1	2.1	2.1	0.98	0.55
Sb	U	U	U	U	U	U	U
Sn	0.061 L	1	0.68	0.89	1.3	0.67	0.38
V	0.0089 L	0.36	0.22	0.36	0.4	0.19	0.097
Zn	0.11	2.6	1.7	2.4	3	1.5	0.89
	piC/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
Co-60	0	2.19	11.9 XYZ	0.877	0 XYZ	18.6 XYZ	0 XYZ
Cs-137	1.32	0.0867	9.56 XYZ	5.47	4.86 XYZ	7.43 XYZ	25.1 XYZ
Pb-212							
Pb-214							
Ra-224							
Ra-226							
Ru-106	23.3	47.9	0 XYZ	0	0 XYZ	80.8 XYZ	0 XYZ
Sb-125	0	0	42.3 XYZ	0	27.7 XYZ	0 XYZ	30.2 XYZ
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
U-Nat	10200	24800	58000	30600	93700	38500	23400

U=Analyzed for but undetected L=Less than CRDL and above MDL
Q=Data can be used qualitatively XYZ=Matrix interference encountered

TEST #1 SOIL WASHING RESULTS
MINUS 0.425mm SLURRY SOILS

	JUNE 1993 PROCESSING						
	B07C91 soil mg/kg	B07C92 soil mg/kg	B07C93 soil mg/kg	B07C95 soil mg/kg	B07C96 soil mg/kg	B07C97 soil mg/kg	B07CB1 soil mg/kg
Ag	2.1	1.5 L	1.1 L	2.2	1.5 L	2.8	1.9 L
Al	7600	7800	7100	8900	10000	9900 Q	6900 Q
As	1.3	1.2	1.2	2.2	1.1	1.7 Q	1 Q
Ba	220	200	190	310	380	390 Q	300 Q
Be	0.24 L	0.23 L	0.18 L	0.1 L	0.22 L	0.2 L	0.21 L
Ca	3900	4000	3800	5100	5000	5400 Q	4100 Q
Cd	U	U	U	U	U	U	U
Co	3.6	4.6	4.9	6	4.7	5.3	5
Cr	34	30	28	45	44	53 Q	40 Q
Cu	320	240	150	420	420	500 Q	260 Q
Fe	12000	13000	15000	19000	14000	15000	14000
Hg	0.3 L	0.2 L	0.35 L	0.49	0.3 L	0.48	0.54
K	670	750	730	800	810	790	650
Mg	3100	3100	3300	3800	3700	3700	3200
Mn	160	180	200	220	180	180	170
Na	540	650	650	710	890	900 Q	620 Q
Ni	34	27	22	40	30	47 Q	29 Q
Pb	13	13	11	16	15	24 Q	17 Q
Sb	U	U	4.4 L	U	U	4.5 L	U
Sn	U	6 L	U	U	6.1 L	U	U
V	37	38	48	61	42	45	39
Zn	35	36	37	44	42	44	39
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0 XYZ	0 XYZ	0 XYZ	0 XYZ	0.0091 XYZ	0.0074 XYZ	0.0077 XYZ
Cs-137	0.152 XYZ	0.118 XYZ	0.138 XYZ	0.174 XYZ	0.279 XYZ	0.303 XYZ	0.224 XYZ
Pb-212	0.596 XYZ	0.604 XYZ	0.834 XYZ	0.828 XYZ	0.724 XYZ	0.821 XYZ	0.917 XYZ
Pb-214	0.511 XYZ	0.403 XYZ	0.556 XYZ	0.424 XYZ	0.518 XYZ	0.478 XYZ	0.619 XYZ
Ra-224	0.608 XYZ	0.616 XYZ	0.85 XYZ	0.84 XYZ	0.734 XYZ	0.832 XYZ	0.55 XYZ
Ra-226	0.461 XYZ	0.459 XYZ	0.534 XYZ	0.448 XYZ	0.458 XYZ	0.509 XYZ	0.929 XYZ
Ru-106	0.0369 XYZ	0.209 XYZ	0.0328 XYZ	0.0307 XYZ	0 XYZ	0.446 XYZ	0.0867 XYZ
Sb-125	0.0251 XYZ	0.0062 XYZ	0.0726 XYZ	0.0429 XYZ	0.0428 XYZ	0 XYZ	0 XYZ
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	217	214	158	173	358	355 Q	827Q

U=Analyzed for but undetected
Q=Data can be used qualitatively
U=Less than CRDL and above MDL
XYZ=Matrix interference encountered

TEST #1 SOIL WASHING RESULTS												
	FRESH WATER (UNFILTERED)					MINUS 0.425mm SLURRY WATER (UNFILTERED)						
	JUNE 1993 PROCESSING					JUNE 1993 PROCESSING						
	B07C70 water mg/L	B07C71 water mg/L	B07C72 water mg/L	B07C73 trp blk mg/L	B07C74 trp blk mg/L	B07C75 water mg/L	B07C76 water mg/L	B07C77 water mg/L	B07C85 water mg/L	B07C79 water mg/L	B07C80 water mg/L	B07C81 water mg/L
Chloroform	0.05	0.02 QH	0.02 Q	U	U	0.01	0.01	0.01 H	0.01	0.0029 H	0.0044 H	0.0064 H
Methyl Ethyl Ketone	U	UH	U	U	U	0.07	U	0.05 H	U	0.18 H	0.03 H	0.02 H
Tetrachloroethylene	U	UH	U	U	U	0.001	0.0013	0.0018 H	0.0016	0.0023 H	0.0025 H	0.0038 H
Tetrahydrofuran	U	UH	U	U	U	U	U	UH	U	0.08 H	UH	UH
Trichloroethylene	U	UH	U	U	U	0.0034	0.0054	0.0064 H	0.0067	0.0077 H	0.0097 H	0.01 H
1,2-Dichloroethane, d4	0.05	0.04 H	0.05	0.05	0.06	0.05	0.06	0.05 H	0.06	0.04 H	0.04 H	0.05 H
Toluene, d8	0.05	0.05 H	0.05	0.05	0.05	0.05	0.05	0.05 H	0.05	0.05 H	0.05 H	0.05 H
4-BromoFluorobenzene	0.05	0.05 H	0.05	0.05	0.05	0.05	0.05	0.05 H	0.05	0.05 H	0.05 H	0.05 H

U=Analyzed for but undetected Q=Data can be used qualitatively H=Holding time missed

TMA Inc. REPORT Work Order # A3-06-092

eceived: 06/30/93 Results by Sample

AMPLE ID 808WL6 FRACTION 02A TEST CODE TCV1 NAME TCLP Volatiles Form 1
Date & Time Collected 06/24/93 Category

TCLP VOLATILE ORGANICS

Sample Matrix (soil/water): WATER
Leachate vol analyzed (mL): 1.0
Date Received: 06/30/93
Date Analyzed: 07/09/93
Instrument ID: 4500

Lab File ID: 30709R05
TCLP Extraction Date: 07/08/93
Date Leachate Extracted:
Dilution Factor: 5.0

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)	Regulatory Limit
71-43-2	Benzene	ND	0.025	
56-23-5	Carbon Tetrachloride	ND	0.025	
108-90-7	Chlorobenzene	ND	0.025	
67-66-3	Chloroform	0.006	0.025	6.0 mg/L
107-06-2	1,2-Dichloroethane	ND	0.025	
75-35-4	1,1-Dichloroethylene	ND	0.025	
78-93-3	Methyl Ethyl Ketone	ND	0.05	
127-18-4	Tetrachloroethylene	ND	0.025	
79-01-6	Trichloroethylene	ND	0.025	
75-01-4	Vinyl Chloride	ND	0.05	

% RECOVERY SURROGATE COMPOUND

d8-Toluene	98
Bromofluorobenzene	105
1,2-Dichloroethane-d4	106

FORM I

000112

TMA Inc. REPORT
Results by Sample

Received: 06/30/93

Work Order # A3-06-092

SAMPLE ID B08ML6 FRACTION 02B TEST CODE TCS1 NAME TCLP Semi-Volatiles Form 1
Date & Time Collected 06/24/93 Category

TCLP SEMI-VOLATILE ORGANICS

Sample Matrix: WATER
Leachate vol (mL): 100
Date Received: 06/30/93
Conc. Extract Vol.(mL): 2
Injection Volume (uL): 1
Instrument ID: SHERMA

Lab File ID: 30720S20
TCLP Extraction Date: 07/08/93
Date Leachate Extracted: 07/08/93
Date Analyzed: 07/20/93
Dilution Factor: 20

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
1319-77-3	Cresol (Total)	ND	0.1
87-86-5	Pentachlorophenol	ND	0.5
95-95-4	2,4,5-Trichlorophenol	ND	0.1
88-06-2	2,4,6-Trichlorophenol	ND	0.1
106-46-7	1,4-Dichlorobenzene	ND	0.1
121-14-2	2,4-Dinitrotoluene	ND	0.1
118-74-1	Hexachlorobenzene	ND	0.1
87-68-3	Hexachlorobutadiene	ND	0.1
67-72-1	Hexachloroethane	ND	0.1
98-95-3	Nitrobenzene	ND	0.1
110-86-1	Pyridine	ND	0.2

% RECOVERY SURROGATE COMPOUND	
2-Fluorophenol	85
Phenol-d5	87
2,4,6-Tribromophenol	80
Nitrobenzene-d5	100
2-Fluorobiphenyl	94
Terphenyl-d14	98

FORM I

TMA Inc. Draft A REPORT
Results by Sample

Work Order # A3-06-092

eceived: 06/30/93

AMPLE ID B08MW0 FRACTION 01C TEST CODE TCP1 NAME TCLP Pesticides Form 1
Date & Time Collected 06/24/93 Category

TCLP CHLORINATED PESTICIDES

Sample Matrix: WATER
Leachate vol (mL): 100
Date Received: 06/30/93
Conc. Extract Vol.(mL): 10
Injection Volume (uL): 1
Column ID: DB-17

Lab File ID: AG12025
TCLP Extraction Date: 07/07/93
Date Leachate Extracted: 07/08/93
Date Analyzed: 07/12/93
Dilution Factor: 10

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
57-74-9	Chlordane	ND	0.005
72-20-8	Endrin	ND	0.001
76-44-8	Heptachlor	ND	0.0005
1024-57-3	Heptachlor Epoxide	ND	0.0005
58-89-9	Lindane	ND	0.0005
72-43-5	Methoxychlor	ND	0.005
8001-35-2	Toxaphene	ND	0.020

% RECOVERY SURROGATE COMPOUND

TCX 85

OCB 73

FORM I

TMA Inc. REPORT
Results by Sample

Received: 06/30/93

Work Order # A3-06-092

SAMPLE ID B08ML6 FRACTION 02B TEST CODE TCH1 NAME TCLP Herbicides Form 1
Date & Time Collected 06/24/93 Category

TCLP CHLORINATED HERBICIDES

Sample Matrix (soil/water): WATER
Lab File ID: AG12015
Leachate vol (mL): 100
TCLP Extraction Date: 07/08/93
Date Received: 06/30/93
Date Leachate Extracted: 07/09/93
Conc.Extract Vol.(mL): 5
Date Analyzed: 07/13/93
Injection Volume (uL): 1
Dilution Factor: 5
Column ID: DB-608

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
94-75-7	2,4-D	ND	0.010
93-72-1	2,4,5-TP	ND	0.0010

% RECOVERY SURROGATE COMPOUND

DCAA 105

FORM I

TMA Inc. Draft A REPORT
Results by Sample

Received: 06/30/93

Work Order # A3-06-092

SAMPLE ID B08MN0 FRACTION 01A TEST CODE TCV1 NAME TCLP Volatiles Form 1
Date & Time Collected 06/24/93 Category

TCLP VOLATILE ORGANICS

Sample Matrix (soil/water): WATER
Leachate vol analyzed (mL): 1.0
Date Received: 06/30/93
Date Analyzed: 07/12/93
Instrument ID: 4500

Lab File ID: 30712R05
TCLP Extraction Date: 07/09/93
Date Leachate Extracted:
Dilution Factor: 5.0

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)	Regulatory Limit
71-43-2	Benzene	ND	0.025	
56-23-5	Carbon Tetrachloride	ND	0.025	
108-90-7	Chlorobenzene	ND	0.025	
67-66-3	Chloroform	0.014	0.025	6.0 mg/L
107-06-2	1,2-Dichloroethane	ND	0.025	
75-35-4	1,1-Dichloroethylene	ND	0.025	
78-93-3	Methyl Ethyl Ketone	ND	0.05	
127-18-4	Tetrachloroethylene	ND	0.025	
79-01-6	Trichloroethylene	ND	0.025	
75-01-4	Vinyl Chloride	ND	0.05	

% RECOVERY SURROGATE COMPOUND

d8-Toluene	107
Bromofluorobenzene	106
1,2-Dichloroethane-d4	107

FORM I

B.2 ANALYTICAL DATA FOR TEST #2

9413095.1623

9413095.1674

TEST #2 SOIL WASHING RESULTS, RAW FEED					
	SEPTEMBER 1993 PROCESSING				
	B07DP9 soil mg/kg	B07DQ0 soil mg/kg	B07DQ1 soil mg/kg	B07DQ2 soil mg/kg	B07DQ3 soil mg/kg
Ag	3.2	4.6	2.8	2.6	4.8
Al	12000	14000	13000	10000	7600
Ba	150	130	130	98	88
Be	0.33	0.28 L	0.45	0.41	0.17 L
Ca	7800	7100	8300	9600	6600
Cd	U	U	U	U	U
Co	13	13	14	12	11
Cr	22	26	17	17	17
Cu	250	380	160	160	240
Fe	33000	33000	35000	32000	30000
Hg	0.45	0.14 L	U	0.16 L	0.12 L
K	1500	1700	1500	1100	670
Mg	6600	7200	6900	6000	5000
Mn	590	510	550	460	380
Na	480	440	440	440	430
Ni	30	31	24	23	36
Pb	7	7.4	5	3.9	5.1
Sb	5.8 L	7 L	5.5 L	5.8 L	U
Sn	U	U	U	U	U
V	86	87	91	89	88
Zn	73	77	72	68	63
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0.0237 U	0.117	0.0496	0.079	0.31
Cs-137	0.0641	0.0905	0.0316	0.0529 U	0.0723
Pb-212	0.608	0.589	0.531	0.535	0.69
Pb-214	0.467	0.506	0.479	0.428	0.496
Ra-224	0.612	0.593	0.535	0.537	0.693
Ra-226	0.455	0.516	0.39	0.344	0.496
Ru-106	-0.0969 U	0.194	0.00646 U	-0.118 U	-0.118 U
Sb-125	0.0481	0.00982 U	0.0314 U	-0.00754U	-0.0375U
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	3.65	13.3	1.72	2.73	6.13
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aroclor-1016	U	U	U	U	U
Aroclor-1221	U	U	U	U	U
Aroclor-1232	U	U	U	U	U
Aroclor-1242	U	U	U	U	U
Aroclor-1248	0.064 L	0.091 L	0.0089 L	0.012 L	0.12
Aroclor-1254	U	U	U	U	U
Aroclor-1260	U	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above MDL

TEST #2 SOIL WASHING RESULTS FRESH WATER (UNFILTERED)				
	SEPTEMBER 1993 PROCESSING			
	B07DQ4 water mg/L	B07DX8 dup. mg/L	B07DQ5 water mg/L	B07DX9 dup. mg/L
Ag	UQ	0.005 LQ	UQ	0.0047 LQ
Al	U	U	U	U
Ba	0.039 Q	0.03 Q	0.028	0.027
Be	U	U	U	U
Ca	38 Q	27 Q	24	24
Cd	U	U	U	U
Co	U	U	U	U
Cr	U	0.0062 L	U	U
Cu	0.078 Q	0.038 Q	0.0054 LQ	UQ
Fe	1.6	1.3	0.12	0.13
Hg	U	U	U	U
K	3 Q	2.1 Q	1.6 Q	2.1 Q
Mg	8.9 Q	6.2 Q	5.3	5.4
Mn	0.067 Q	0.032 Q	0.0063 L	0.0069 L
Na	9.5 Q	5.3 Q	4.3	4.1
Ni	U	U	U	U
Pb	0.037 Q	0.01 Q	0.00097 L	0.0016 L
Sb	U	U	U	U
Sn	U	U	U	U
V	U	U	0.0053 L	U
Zn	0.024 Q	0.012 Q	U	0.0045 L
	pCi/L	pCi/L	pCi/L	pCi/L
Co-60	0.146 U	5.25	1.29 U	4.55 U
Cs-137	1.39 U	4.51 U	3.1 U	3.3 U
Ru-106	-44.3 U	4.35 U	-32.3 U	-0.728 U
Sb-125	5.77 U	-3.15 U	12.2 U	-15.3 U
	ug/L	ug/L	ug/L	ug/L
U-Nat	1.63 Q	0.693 Q	0.805	0.702
	mg/L	mg/L	mg/L	mg/L
Aroclor-1016	U	U	U	U
Aroclor-1221	U	U	U	U
Aroclor-1232	U	U	U	U
Aroclor-1242	U	U	U	U
Aroclor-1248	U	U	U	U
Aroclor-1254	U	U	U	U
Aroclor-1260	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above MDL
Q=Data can be used qualitatively

TEST #2 SOIL WASHING RESULTS
25 mm TO 2mm

	SEPTEMBER 1993 PROCESSING											
	B07DV2 soil mg/kg	B07DV3 soil mg/kg	B07DV4 soil mg/kg	B07DV5 soil mg/kg	B07DV6 soil mg/kg	B07DV7 soil mg/kg	B07DV8 soil mg/kg	B07DV9 soil mg/kg	B07DW0 soil mg/kg	B07DW1 soil mg/kg	B07DW2 soil mg/kg	B07DW3 soil mg/kg
Ag	1.2 L	1 L	0.73 L	1.1 L	0.84 L	0.96 L	0.67 L	0.86 L	1.1 L	0.95 L	0.76 L	0.78 L
Al	4900	5700	4200	5400	3900	5400	4000	3500	4100	3400	3100	3900
Ba	67	45	61	80	81	73	85	69	71	69	59	80
Be	0.29 L	0.22 L	0.13 L	0.3 L	0.13 L	0.31	0.2 L	0.23 L	0.25 L	0.23 L	0.13 L	0.19 L
Ca	5500	5800	4400	6500	5100	7000	5600	4900	5600	4900	5500	4600
Cd	U	U	U	U	U	U	U	U	U	U	U	U
Co	9.4	8.7	7.8	11	8.6	10	8.9	8.9	11	8.8	7.7	8.1
Cr	6.3	4.3	3.2	4.5	3.9	4.8	2.7	3.3	4.7	6	2.1	4.3
Cu	240	140	140	270	160	66	180	150	190	130	38	190
Fe	26000	24000	31000	22000	22000	26000	24000	23000	29000	25000	22000	21000
Hg	U	U	U	U	U	U	U	U	U	U	U	U
K	440	260	350	270	230	350	280	240	290	360	260	380
Mg	3700	3200	2900	3700	3000	3900	3600	3400	4700	2500	3100	4200
Mn	290	260	220	340	240	270	310	250	340	290	210	180
Na	280	370	240	450	310	500	330	320	310	320	220	290
Ni	15	8.5	7.7	13	7.5	7	12	10	12	6.8	4.1	6.7
Pb	2	2.4	2.1	2.8	1.1	1.8	1.9	1.6	1.8	2.3	1.7	1.6
Sb	U	6.1 L	5.3 L	U	4.6 L	U	U	U	4.4 L	U	U	U
Sn	U	U	U	U	U	U	U	U	U	U	U	U
V	78	64	62	71	62	69	41	67	73	76	58	46
Zn	53	53	54	64	51	56	49	48	53	48	45	42
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Co-60	0.129	0.155	0.125	0.133	0.034	0.0906	0.168	0.08	0.0947	0.0643	0.12	0.0793
Cs-137	0.121	0.124	0.116	0.196	0.0587	0.101	0.167	0.113	0.0863	0.115	0.112	0.105
Pb-212	0.576	0.523	0.463	0.48	0.526	0.493	0.604	0.741	0.536	0.627	0.686	0.563
Pb-214	0.451	0.5	0.39	0.47	0.484	0.431	0.509	0.632	0.494	0.6	0.609	0.502
Ra-224	0.579	0.526	0.466	0.483	0.529	0.495	0.607	0.745	0.54	0.632	0.691	0.567
Ra-226	0.509	0.484	0.371	0.38	0.373	0.448	0.678	0.592	0.452	0.601	0.549	0.449
Ru-106	-0.075U	0.032U	-0.036U	-0.008U	-0.076U	0.1 U	-0.033U	-0.032U	-0.0844U	-0.0281U	-0.007U	-0.043U
Sb-125	-0.001U	-0.006U	-0.004U	-0.044U	-0.009U	-0.001U	0.09	-0.000U	0.0121U	0.0452U	-0.015U	0.003 U
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
U-Nat	2.01	1.37	1.33	2.02	0.912	1.53	2.13	0.857	1.23	1.07	1.32	1.4
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aroclor-1016	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1221	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1232	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1242	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1248	.0047 L	.0087L	.0039 L	.029 L	.0041 L	.0052 L	.0047 L	.0049 L	.0024 L	.0033 L	.0048 L	.0084 L
Aroclor-1254	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1260	U	U	U	U	U	U	U	U	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above MDL

9413095.1677

TEST #2 SOIL WASHING RESULTS
2mm TO 0.425mm

	SEPTEMBER 1993 PROCESSING											
	B07DW4 soil mg/kg	B07DW5 soil mg/kg	B07DW6 soil mg/kg	B07DW7 soil mg/kg	B07DW8 soil mg/kg	B07DW9 soil mg/kg	B07DX0 soil mg/kg	B07DX1 soil mg/kg	B07DX2 soil mg/kg	B07DX3 soil mg/kg	B07DX4 soil mg/kg	B07DX s mg/
Ag	3.9	3.3	4.4	7.1	3.5	3.8	4.1	3.6	2.9	5.5	3.6	2
Al	8400	7000	8000	7600	7200	8200	8900	7200	6800	7100	6800	760
Ba	120	97	89	88	91	120	91	86	85	83	79	8
Be	0.49	0.23 L	0.45	0.51	0.26 L	0.48	0.38	0.23 L	0.22 L	0.3	0.22 L	0.3
Ca	7600	6300	7600	7200	6600	7600	8500	7000	6300	6700	6200	740
Cd	U	U	U	U	U	U	U	U	U	U	U	U
Co	15	11	12	12	12	12	12	11	10	11	11	1
Cr	20	16	21	22	23	22	18	22	13	21	16	1
Cu	630	520	720	910	620	620	700	550	450	1100	600	31
Fe	36000	33000	34000	34000	33000	35000	35000	33000	32000	33000	33000	3400
Hg	0.27 L	0.13 L	0.14 L	U	0.32 L	0.3 L	0.17 L	0.12 L	0.28 L	0.48	0.16 L	0.25 L
K	700	560	540	630	560	600	590	550	500	590	500	51
Mg	5900	5200	5600	5300	6500	5400	5300	6200	5200	5300	5000	550
Mn	550	400	400	380	440	410	410	380	360	370	380	39
Na	520	400	500	510	440	440	770	500	370	370	380	54
Ni	32	26	33	31	41	37	31	37	24	35	25	2
Pb	5.9	2.9	4.9	4.9	4.9	4.8	5.4	5	4.6	6.1	5.5	4
Sb	U	U	U	4.9 L	U	U	6.5 L	4.5 L	U	5.8 L	5.3 L	U
Sn	U	U	U	U	U	U	U	U	U	U	U	U
V	110	94	96	100	92	110	92	100	96	100	100	9
Zn	81	74	83	86	76	80	82	77	72	410	76	7
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pC
Co-60	0.249	0.208	0.319	0.25	0.255	0.239	0.308	0.187	0.254	0.323	0.278	0.24
Cs-137	0.251	0.209	0.281	0.199	0.253	0.243	0.312	0.221	0.259	0.331	0.276	0.23
Pb-212	0.565	0.61	0.775	0.662	0.588	0.614	0.654	0.628	0.717	0.803	0.766	0.67
Pb-214	0.417	0.375	0.417	0.462	0.465	0.456	0.42	0.39	0.351	0.476	0.558	0.47
Ra-224	0.568	0.614	0.779	0.666	0.592	0.618	0.657	0.632	0.72	0.808	0.771	0.67
Ra-226	0.375	0.455	0.424	0.388	0.496	0.39	0.399	0.43	0.355	0.433	0.418	0.43
Ru-106	-0.097 U	0.008 U	-0.13 U	0.15 U	-0.03 U	-0.04 U	0.039 U	-0.015 U	0.0414 U	-0.016 U	-0.14 U	-0.108 U
Sb-125	-0.007 U	0.026 U	0.006 U	0.005 U	-0.07 U	-0.05 U	-0.029 U	-0.013 U	0.0558	-0.01 U	0.12	-0.0176 U
	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pC
U-Nat	23.8	4.07	14.9	23.5	9.61	6.19	17.9	9.63	16.8	4.62	4.18	9.3
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/
Aroclor-1016	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1221	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1232	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1242	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1248	0.26	0.27	0.28	0.34	0.19	0.3	0.32	0.33	0.28	0.44	0.27	0.2
Aroclor-1254	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor-1260	U	U	U	U	U	U	U	U	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above the MDL

TEST #2 SOIL WASHING RESULTS
MINUS 0.425mm SLURRY SOILS

	SEPTEMBER 1993 PROCESSING		
	B07DS7 soil mg/kg	B07DS8 soil mg/kg	B07DS9 soil mg/kg
Ag	3.2	6.6	4.4
Al	8600	7800	7200
Ba	330	240	90
Be	U	U	0.13 L
Ca	5500	4600	5100
Cd	U	U	U
Co	7.5	7.6	8.3
Cr	54	46	24
Cu	360	700	680
Fe	25000	24000	24000
Hg	0.43	0.31 L	U
K	730	730	590
Mg	4100	4100	4300
Mn	250	300	310
Na	450	330	320
Ni	38	42	35
Pb	16	16	6.9
Sb	U	U	U
Sn	11	9.5 L	U
V	71	68	73
Zn	52	92	83
	pCi/g	pCi/g	pCi/g
Co-60	0.0412	0.255	0.431
Cs-137	0.212	0.287	0.322
Pb-212	1.21	1.07	0.868
Pb-214	0.822	0.657	0.564
Ra-224	1.21	1.07	0.872
Ra-226	0.72	0.622	0.554
Ru-106	-0.285 U	-0.292 U	-0.0898 U
Sb-125	0.0271 U	0.0179 U	0.0302 U
	pCi/g	pCi/g	pCi/g
U-Nat	115	134	31.9
	mg/kg	mg/kg	mg/kg
Aroclor-1016	U	U	U
Aroclor-1221	U	U	U
Aroclor-1232	U	U	U
Aroclor-1242	U	U	U
Aroclor-1248	0.97	0.66	0.35
Aroclor-1254	U	U	U
Aroclor-1260	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above MDL
Q=Data can be used qualitatively

9413095.1679

TEST #2 SOIL WASHING RESULTS
MINUS 0.425 SLURRY WATER

	SEPTEMBER 1993 PROCESSING							
	B07DT2 water-uf mg/L	B07DT3 water-f mg/L	B07DT4 water-uf mg/L	B07DT5 water-f mg/L	B07DT6 water-uf mg/L	B07DT7 water-f mg/L	B07DT8 water-uf mg/L	B07DV0 water-uf mg/L
Ag	0.033	U	0.023	0.0042 L	0.014 L	U	0.0079 L	0.0076 L
Al	28	0.15 L	15	U	12	0.044 L	4.4	4.8
Ba	1.9	0.063	0.22	0.043	0.16	0.025	0.076	0.082
Be	U	0.0011 L	U	U	U	U	U	U
Ca	33	19	26	29	27	23	24	25
Cd	U	U	U	U	U	U	U	U
Co	0.0064 L	U	0.0074 L	U	0.006 L	U	U	U
Cr	0.27	U	0.097	U	0.048	0.0066 L	0.019 L	0.022
Cu	3.8	0.019 L	1.7	0.039	0.71	0.029	0.24	0.33
Fe	18	0.059	11	0.056	11	0.077	3.3	3.5
Hg	0.0031	U	0.0019	U	0.0031	U	0.00047	0.00035
K	3.4	1.2	4.1	2.8	4.2	2.4	3.5	3.9
Mg	11	4.9	8.9	4.3	8.6	5.1	6.3	6.2
Mn	0.32	0.0051 L	0.27	0.02	0.26	0.015	0.068	0.092
Na	15	13	7.6	5.4	6	5.1	5.4	5.2
Ni	0.3	U	0.098	U	0.044	U	0.02 L	U
Pb	0.065	0.0006 L	0.013	U	0.0088	0.0012 L	0.0021 L	0.0035 L
Sb	U	U	U	U	U	U	U	U
Sn	U	U	U	U	U	U	U	U
V	0.017 L	U	0.02 L	U	0.022 L	U	0.0083 L	0.0092 L
Zn	0.18	U	0.079	U	0.052	0.0065 L	0.017	0.02
	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
Co-60	3.67 U	-4.81 U	-1.39 U	-8.24 U	-4.55 U	-4.37 U	5.28 U	-7.29 U
Cs-137	2.26 U	-1.47 U	-7.4 U	-2.24 U	5.56	3.64 U	-4.72 U	-2.6 U
Ru-106	-2.91 U	5.8 U	25.1 U	-26.5 U	10.9 U	0 U	27.8 U	13 U
Sb-125	13.2 U	12.6	7.73 U	-4.7 U	-7.22 U	-18.4 U	14.4 U	-5.76 U
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
U-Nat	2.68	19.7	664	510	3.16	3.68	1.49	10.9
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Aroclor-1016	U	U	U	U	U	U	U	U
Aroclor-1221	U	U	U	U	U	U	U	U
Aroclor-1232	U	U	U	U	U	U	U	U
Aroclor-1242	U	U	U	U	U	U	U	U
Aroclor-1248	0.0013	U	0.00075 L	U	0.00028 L	U	0.00025 L	0.00021 L
Aroclor-1254	U	U	U	U	U	U	U	U
Aroclor-1260	U	U	U	U	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above MDL

TEST #2 SOIL WASHING RESULTS										
	SEPTEMBER 1993 PROCESSING									
	FRESH WATER		MINUS 0.425mm SLURRY WATER					BLANKS		
	B07DQ4 water-uf mg/L	B07DX8 dup.-uf mg/L	B07DT2 water-uf mg/L	B07DT4 water-uf mg/L	B07DT6 water-uf mg/L	B07DT8 water-uf mg/L	B07DV0 water-uf mg/L	B07DY0 full blk mg/L	B07DY2 trp blk mg/L	B07DY3 trp blk mg/L
1,1,1-Trichloroethane	U	0.0018 L	U	0.0028 L	U	U	0.0029 L	U	U	U
1,1,2-Trichloroethane	U	U	U	U	U	U	U	U	U	U
1,1-Dichloroethane	U	U	U	U	U	U	U	U	U	U
1,2-Dichloroethane	U	U	U	U	U	U	U	U	U	U
1,2-Dichloroethene	U	U	U	U	U	U	U	U	U	U
1,4-Dichlorobenzene	U	U	U	U	U	U	U	U	U	U
1-Butanol	U	U	U	U	U	U	U	U	U	U
4-Methyl-2-pentanone	U	U	U	U	U	U	U	U	U	U
Acetone	U	U	U	U	U	U	U	U	U	U
Benzene	U	U	U	U	U	U	U	U	U	U
Carbon disulfide	U	U	U	U	U	U	U	U	U	U
Carbon tetrachloride	U	U	U	U	U	U	U	U	U	U
Chloroform	0.0074	0.0069	U	U	U	U	U	U	U	U
Ethyl cyanide	U	U	U	U	U	U	U	U	U	U
Methyl ethyl ketone	U	U	0.05	U	U	U	U	U	U	U
Methylene chloride	U	U	U	U	U	U	U	U	U	U
Tetrachloroethene	U	U	U	U	U	U	U	U	U	U
Tetrahydrofuran	UQ	0.007 LQ	0.042	0.018	0.011	0.0084 L	0.0074 L	U	U	U
Toluene	U	U	U	U	U	U	U	U	U	U
Trichloroethene	U	U	0.00092	U	U	U	U	U	U	U
Vinyl chloride	U	U	U	U	U	U	U	U	U	U
Xylenes (total)	U	U	U	U	U	U	U	U	U	U

U=Analyzed for but undetected L=Less than the CRDL and above the MDL

9413095.1691

TEST #2 SOIL WASHING RESULTS
TRIP BLANKS

	SEPTEMBER 1993 PROCESSING			
	B07DY5 soil mg/kg	B07DY6 soil mg/kg	B07DY0 water mg/L	B07DY1 water mg/L
Ag	U	U	0.0034 L	0.0029 L
Al	69 Q	80 Q	U	U
Ba	0.28 LQ	0.33 LQ	0.00023 LQ	0.00046 LQ
Be	U	U	U	U
Ca	14 Q	14 Q	0.039 L	0.03 L
Cd	U	U	U	U
Co	U	U	U	0.0063 L
Cr	U	U	U	U
Cu	1.1 L	U	U	U
Fe	140 Q	150 Q	U	U
Hg	U	U	U	U
K	51 L	U	0.88 L	0.82 L
Mg	7.2 LQ	6.9 LQ	U	U
Mn	0.67 LQ	0.38 LQ	U	U
Na	U	25 L	U	U
Ni	U	U	U	U
Pb	U	U	0.0031 L	0.0007 L
Sb	U	U	U	U
Sn	U	U	U	U
V	U	0.64 L	U	U
Zn	0.63 L	0.7 L	U	U
	pCi/g	pCi/g	pCi/L	pCi/L
Co-60	-0.008 U	-0.006 U	-6.94 U	4.51 U
Cs-137	0.012 U	-0.01 U	2.29 U	1.55 U
Pb-212	0.0765	0.0852	16.7 U	44.5
Pb-214	0.115	0.0949	4.41 U	-0.157 U
Ra-224	0.077	0.0858		
Ra-226	0.151	0.0917		
Ru-106	-0.002 U	0.004 U		
Sb-125	-0.042 U	0.016 U		
	pCi/g	pCi/g	ug/L	ug/L
U-Nat	-0.232 U	-0.187 U	0.0675 U	0.0713 U
	mg/kg	mg/kg	mg/L	mg/L
Aroclor-1016	U	U	U	U
Aroclor-1221	U	U	U	U
Aroclor-1232	U	U	U	U
Aroclor-1242	U	U	U	U
Aroclor-1248	U	U	U	U
Aroclor-1254	U	U	U	U
Aroclor-1260	U	U	U	U

U=Analyzed for but undetected L=Less than CRDL and above the MDL

Westinghouse Hanford Company

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page 1 of 1

006947

Collector CE ZERBY
Company Contact R.D. BELDEN/W.E. STROHBEN
Telephone 509-372-1226
SAF No. 93-294
Project Designation SOIL WASHING TEST -2
Sampling Location 300-FF-1
Ice Chest No. 8ML269
Bill of Lading/Airbill No. 997333046
Offsite Property No.
Method of Shipment AIR LIFTED VIA BURLINGTON AIR
Field Logbook No. WHC-N-2085 #2
Shipped to TMA/NORCAL
Possible Sample Hazards/Remarks NONE KNOWN
Special Handling and/or Storage SAMPLES TO BE KEPT AT 4 DEGREES C UNTIL ANALYSIS. SAMPLES TAKEN TO RCRA PROTOCOL

Sample Number	*	Date Collected	Time	Number and Type of Containers	Analysis Required	Preservative
B09757	SE	9-8-93	1005	2, aG 950 ml	TCLP ANALYSIS-COMPLETE ICP/GFAA METALS, Hg, SEMI-VOA, PESTICIDES, HERBICIDES METHOD 1311	NONE
B09757	SE	↓	1005	1, aGs 250 ml	VOA 1311	

Chain of Possession (Sign and Print Names)

Relinquished By	Date/Time	Received By	Date/Time
CE Zerbe	9/10/93 1110	H. NARCISO	9/13/93 8:00
Relinquished By	Date/Time	Received By	Date/Time
Relinquished By	Date/Time	Received By	Date/Time

SPECIAL INSTRUCTIONS
not Enough Sample To complete entire Volume Requested

*Matrix
A = Air
DL = Drum Liquids
DS = Drum Solids
L = Liquid
O = Oil
S = Soil
SE = Sediment
SL = Sludge
SO = Solid
T = Tissue
W = Water
WI = Wipe
X = Other

LABORATORY SECTION
Received By
Title SAMPLE CONTROL TECHNICIAN
Date/Time 9/13/93 8:00
Final Sample Disposition
Disposal Method:
Disposed by:
Date/Time:

RECEIVED ON 9/11/93 (Saturday Delivery) OPENED: 9/13/93 8:00 AM

12/06/93 14:54

WHC HASM 345-HILLS
DOE/RL-93-96
Draft A

B.2-11

000002A

TMA Inc. REPORT

Received: 09/13/93

Results by Sample

Work Order # A3-09-023

SAMPLE ID 809757 FRACTION 01A TEST CODE TCV1 NAME TCLP Volatiles Form 1

Date & Time Collected 09/08/93 Category

TCLP VOLATILE ORGANICS

Sample Matrix (soil/water): SOIL

Leachate vol analyzed (mL): 1

Date Received: 09/13/93

Date Analyzed: 09/17/93

Instrument ID: MINNIE

Lab File ID: 30917M06

TCLP Extraction Date: 09/15/93

Date Leachate Extracted:

Dilution Factor: 5

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
71-43-2	Benzene	ND	0.025
56-23-5	Carbon Tetrachloride	ND	0.025
108-90-7	Chlorobenzene	ND	0.025
67-66-3	Chloroform	ND	0.025
107-06-2	1,2-Dichloroethane	ND	0.025
75-35-4	1,1-Dichloroethylene	ND	0.025
78-93-3	Methyl Ethyl Ketone	ND	0.050
127-18-4	Tetrachloroethylene	ND	0.025
79-01-6	Trichloroethylene	ND	0.025
75-01-4	Vinyl Chloride	ND	0.050

% RECOVERY SURROGATE COMPOUND

d8-Toluene	95
Bromofluorobenzene	95
1,2-Dichloroethane-d4	99

FORM I

000071

DOE/RL-93-96

TMA Inc. Draft A REPORT

Results by Sample

Received: 09/13/93

Work Order # A3-09-023

SAMPLE ID B09757 FRACTION 01D TEST CODE TCS1 NAME TCLP Semi-Volatiles Form 1

Date & Time Collected 09/08/93 Category

TCLP SEMI-VOLATILE ORGANICS

Sample Matrix: SOIL
Leachate vol (mL): 100
Date Received: 09/13/93
Conc. Extract Vol.(mL): 2
Injection Volume (uL): 1
Instrument ID: SHERMA

Lab File ID: 30922S03
TCLP Extraction Date: 09/15/93
Date Leachate Extracted: 09/20/93
Date Analyzed: 09/22/93
Dilution Factor: 20

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
1319-77-3	Cresol (Total)	ND	0.1
87-86-5	Pentachlorophenol	ND	0.5
95-95-4	2,4,5-Trichlorophenol	ND	0.1
88-06-2	2,4,6-Trichlorophenol	ND	0.1
106-46-7	1,4-Dichlorobenzene	ND	0.1
121-14-2	2,4-Dinitrotoluene	ND	0.1
118-74-1	Hexachlorobenzene	ND	0.1
87-68-3	Hexachlorobutadiene	ND	0.1
67-72-1	Hexachloroethane	ND	0.1
98-95-3	Nitrobenzene	ND	0.1
110-86-1	Pyridine	ND	0.2

% RECOVERY SURROGATE COMPOUND

2-Fluorophenol	60
Phenol-d5	66
2,4,6-Tribromophenol	68
Nitrobenzene-d5	83
2-Fluorobiphenyl	92
Terphenyl-d14	93

FORM I

000131

DOE/RL-93-96

TMA Inc. Draft A REPORT

Results by Sample

Received: 09/13/93

Work Order # A3-09-023

SAMPLE ID 809757 FRACTION 01D TEST CODE TCP1 NAME TCLP Pesticides Form 1

Date & Time Collected 09/08/93 Category

TCLP CHLORINATED PESTICIDES

Sample Matrix: SOIL

Leachate vol (mL): 100

Date Received: 09/13/93

Conc. Extract Vol.(mL): 10

Injection Volume (uL): 1

Column ID: DB-1701

Lab File ID: BJ10025

TCLP Extraction Date: 09/15/93

Date Leachate Extracted: 09/20/93

Date Analyzed: 10/10/93

Dilution Factor: 1

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
57-74-9	Chlordane	ND	0.005
72-20-8	Endrin	ND	0.001
76-44-8	Heptachlor	ND	0.0005
1024-57-3	Heptachlor Epoxide	ND	0.0005
58-89-9	Lindane	ND	0.0005
72-43-5	Methoxychlor	ND	0.005
8001-35-2	Toxaphene	ND	0.020

% RECOVERY SURROGATE COMPOUND

TCX 76

DCB 54

FORM I

DOE/RL-93-96
Draft A

000290

TMA Inc. REPORT Work Order # A3-09-023

Received: 09/13/93

Results by Sample

SAMPLE ID B09757 FRACTION 01D TEST CODE TCH1 NAME TCLP Herbicides Form 1

Date & Time Collected 09/08/93 Category

TCLP CHLORINATED HERBICIDES

Sample Matrix (soil/water): SOIL

Lab File ID: AJ11013

Leachate vol (mL): 50

TCLP Extraction Date: 09/15/93

Date Received: 09/13/93

Date Leachate Extracted: 09/28/93

Conc.Extract Vol.(mL): 2.5

Date Analyzed: 10/11/93

Injection Volume (uL): 1

Dilution Factor: 1

Column ID: DB-608

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)
94-75-7	2,4-D	ND	0.01
93-72-1	2,4,5-TP	ND	0.001

% RECOVERY SURROGATE COMPOUND

DCAA 90

FORM I

DOE/RL-93-96

TMA Inc. Draft A REPORT

Results by Sample

Work Order # A3-09-023

Received: 09/13/93

SAMPLE ID B09757 FRACTION 01D TEST CODE TCM1 NAME TCLP Metals Form 1

Date & Time Collected 09/08/93 Category

TCLP METALS

Sample Matrix: SOIL TCLP Extraction Date: 09/15/93

Date Received: 09/13/93

CAS No.	COMPOUND	RESULT (mg/L)	PQL (mg/L)	METHOD
7440-38-2	Arsenic	0.003	0.001	F
7440-39-3	Barium	2.65	0.001	P
7440-43-9	Cadmium	0.008	0.007	P
7440-47-3	Chromium	0.057	0.006	P
7439-92-1	Lead	0.019	0.001	F
7439-97-6	Mercury	0.0030	0.0002	CV
7782-49-2	Selenium	ND	0.002	F
7440-22-4	Silver	0.07	0.01	A

Analytical Methods Used:

P = ICP A = Flame AA F = Furnace AA

CV = Cold Vapor AA

FORM I

From: Geochemistry & Hydrochemistry
Phone: 376-3324
Date: December 3, 1993
Subject: DATA VALIDATION OF 300-FF-1 SOIL WASHING COLLECTED JUNE 1993

To: R. D. Belden

cc: J. C. Johnston
D. G. Horton

This report is to document the validation of 300-FF-1 Soil Washing data collected during JUNE 1993. The validation was based on WHC-CM-7-8 manual "Environmental Engineering and Geotechnology Function Procedures" (WHC 1992) and the "Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1992" Appendix B DOE/RL-93-09 (DOE-RL, 1993a).

The data were collected, analyzed and processed in a similar manner as the Resource Conservation and Recovery Act (RCRA) groundwater monitoring projects. The analytical laboratories utilized were Datachem Laboratory, Salt Lake City Utah and International Technology Analytical Services, Richland, Washington. Data validation was performed by Ms. P.B. Freeman, RCRA Sampling and Analysis Task Leader. A electronic copy of the data is provide in both paradox and lotus format. Hardcopies of data were provided prior to this report.

Data validation consisted of seven parts:
a. 100% verification that requested data were received.
b. 100% verification that holding times were meet.
c. 100% evaluation of precision with field duplicates
d. 100% evaluation of potential sample contamination with field blank data.
e. 100% evaluation of laboratory MS/MSD and surrogate data through laboratory incident reports.
f. 100% evaluation of laboratory blanks.
g. 100% evaluation of data completeness.

The outcome of the validation:
Part a: All data requested were not received. Sample numbers B07C86 and B07C87 were not received. These were for VOA analyses only as they were Trip blank # 3 and Trip blank # 4, respectfully.

Part b: All analytical holding times were not met. VOA analyses for the following samples numbers exceeded required holding times. These data have been flagged with "H" validation flag. The H-flagged data can be used

qualitatively, but no regulatory decisions should be made based on a single flagged analytical result. The sample numbers are B07C77, B07C79, B07C80, B07C81, B07CB2, B07CB3, B07C71.

Part c:
Evaluation of Duplicate data was performed using procedure 2.1 "Evaluation of RCRA Groundwater Field Duplicate and Blank Sample Data" (WHC 1992) and using Appendix B (DOE-RL 1993).

There were two water matrix and three soil matrix duplicate pairs evaluated. The water matrix paired sample numbers are B07C71 with B07C72 and B07C76 with B07C85, respectfully. The evaluation identifies constituents which exceeded a required 25% relative percentage difference (WHC 1992) and was above the limit of detection as defined in Appendix B (DOE-RL 1993).

The evaluation of B07C71 and B07C72 identified one constituent. The constituent is chloroform which was analyzed by method SW-846 8240.

The evaluation of B07C76 and B07C85 identified one constituent. The constituent is barium which was analyzed by method SW-846 6010.

The soil matrix paired sample numbers are B07C31 with B07C68 B07C97 with B07CB1 and B07C11 with B07C67, respectfully. The evaluation of B07C31 and B07C68 identified four constituents. The constituents are tin which was analyzed by method SW-846 6010; Arsenic which was analyzed by method SW-846 7060; uranium and radium-224 which were analyzed by International Technology Analytical Services inhouse methods.

The evaluation of B07C97 and B07CB1 identified ten constituents. The constituents are aluminum, barium, calcium, chromium, copper, nickel, sodium which were analyzed by method SW-846 6010; lead which is analyzed by method SW-846 7421; arsenic which is analyzed by method SW-846 7060 and uranium which was analyzed by International Technology Analytical Services inhouse method.

The evaluation of B07C11 and B07C67 identified nine constituents. The constituents are antimony, barium, chromium, copper, tin which were analyzed by method SW-846 6010; and uranium, cesium-137, lead-212, radium-224 which were analyzed by International Technology Analytical Services inhouse methods.

As a result of this evaluation all data associated with these sample numbers and constituents are flagged with a validation flag of Q. The Q-flagged data can be used qualitatively, but not regulatory decisions should be made based on a single flagged data point.

Part d: Evaluation of field blank data was performed using procedure 2.1 "Evaluation of RCRA Groundwater Field Duplicate and Blank Sample Data" (WHC 1992) and using Appendix B (DOE-RL 1993).

There were six water blanks collected during the June 1993 sampling. Results from two blanks were not received (see part a). The blanks exceeding two times the method detection limit (MDL) were flagged with a Q (WHC 1992). MDL are defined in Appendix B (DOE-RL 1993). The sample numbers for the water blanks are B07C73, B07C74, B07CB2, B07CB3, B07C86 and B07C87. Only samples B07CB2 and B07CB3 had one constituent exceed two times the MDL. The constituent was the same for each sample number and was methylene chloride which is analyzed by method SW-846 8240.

As a result of this evaluation the above constituents associated with the collect and analyze dates of these sample numbers and constituents are flagged with a validation flag of Q. The Q-flagged data can be used qualitatively, but not regulatory decisions should be made based on a single flagged data point.

Part e: There were three laboratory incident reports for this data. One incident report consisted of a sample analyzed by wrong uranium in-house method and was reanalyzed properly and reported without comment code. The other two reports described matrix interference which caused higher detection limits and false results in the gamma scan analysis. The effected samples for the gamma scan are flagged with a XYZ in the comment code. All the incident reports are attached for information. Otherwise, no data was found to have matrix spike, matrix spike duplicate or surrogate samples exceeding laboratory acceptance criteria.

Part f: There were no "B" qualifiers associated with these data, therefore no laboratory blanks exceeded laboratory acceptance criteria.

Part g: The data completeness is determined after data validation is completed and is calculated by the number of unflagged divided by the total number of validated data expressed as a percentage. The RCRA using a 80% acceptance guidance. The total number of soil data are 1302 constituents and water data are 578 constituents. The total unflagged soil data are 1256 constituents and water data are 421 constituents. The calculated completeness for soil and water data are 96.5% and 73%, respectfully. The soil data is within acceptable completeness criteria. The water data is below acceptable completeness criteria and may need to be evaluated further for its regulatory uses.

References:

DOE-RL, 1993, Annual Report for RCRA Groundwater monitoring Projects at Hanford Site Facilities for 1992, DOE/RL-93-09, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC, 1992, Environmental Engineering and Geotechnology Function Procedures, WHC-CM-78, vol. 4, Westinghouse Hanford Company, Richland, Washington.

P. B. Freeman
RCRA Sampling and Analysis Task Team Leader

pbf

ATTACHMENT 1

INTERNATIONAL TECHNOLOGY CORPORATION

Mr. William L. Acker, Jr.
Battelle, PNL
P.O. Box 999 M/S K3-20
Richland, WA 99352

July 20, 1993

Dear Mr. Acker:

Subject: CONTRACT 163635-A-M1

This letter is a follow up of an oral incident report made to your office by Suzanne Root July 19, 1993. This report is made pursuant to Article II, Subarticle 8 of the subject contract.

The following sample was received on July 02, 1993. On the final review of the report, an error was discovered that required a reanalysis be performed. Due to the sample's priority status the sample and associated QC samples were reanalyzed using the Laser Phosphorimeter, a faster method of analysis than the Fluorometer. The laser data generated for the sample was reported to PNL July 16, 1993. The use of the Laser Phosphorimeter has not been approved for samples submitted under the subject contract.

Sample ID#	Chain of Custody#	IT Sample ID#
B07C55	48681	W3-07-040-03

Root Cause: The mistake was an oversight on the part of the project manager.

Corrective Action: The sample is being reanalyzed using approved instrumentation. Results will be re-reported using the "M" code for modified.

Sincerely,

Richard L Merrell

Richard L. Merrell
Deputy Laboratory Director

CC: Doug Swenson
Van Pettey
Suzanne Root

PNL LTR 072793

RM:scr

Regional Office
2800 George Washington Way • Richland, Washington 99352 • 509-375-3131
IT Corporation is a wholly owned subsidiary of International Technology Corporation

RECEIVED
JUL 20 1993
W.L. ACKER

2

INTERNATIONAL TECHNOLOGY CORPORATION

Mr. William L. Acker, Jr.
Battelle, PNL
P.O. Box 999 M/S K3-20
Richland, WA 99352

July 20, 1993

Dear Mr. Acker:

Subject: CONTRACT 163635-A-M1

This letter is a follow up of an oral incident report made to your office by Suzanne Root July 19, 1993. This report is made pursuant to Article II, Subarticle 8 of the subject contract.

The following samples were received on July 07, 1993. The sample results did not meet the contractual detection limit of 20 pCi/L for the gamma scan analysis.

Sample ID#	Chain of Custody#	IT Sample ID#	DL Achieved
B07C77 Slurry 3	48743	W3-07-084-01	39.57 pCi/L
B07C79 Slurry 5	48749	W3-07-084-01	53.09 pCi/L
B07C80 Slurry 6	48752	W3-07-084-01	34.74 pCi/L
B07C81 Slurry 7	48755	W3-07-084-01	36.00 pCi/L

Root Cause: Matrix effect. The samples were muddy. A 500 ml geometry was used for a direct count of these samples.

Corrective Action: Results will be reported using the XYZ comment code.

Sincerely,

Richard L Merrell

Richard L. Merrell
Deputy Laboratory Director

CC: Doug Swenson
Van Pettey
Suzanne Root

RM:scr

1 of 2

3

INTERNATIONAL TECHNOLOGY CORPORATION

Mr. William L. Acker, Jr.
Battelle, PNL
P.O. Box 999 M/S K3-20
Richland, WA 99352

July 15, 1993

Dear Mr. Acker:

Subject: CONTRACT 163635-A-M1

This letter is regarding priority samples received July 2, and July 7, 1993, (see Attachment 1 for a listing of PNL sample ID numbers). These samples were submitted for gamma analyses. The gamma spectrometry results indicated high levels of uranium. In addition to the uranium, the computer detected Nb-95 and Xe-131 in each of the samples. It is our professional opinion that the high levels of uranium are causing the Nb-95 and Xe-131 to be identified as detected when actually the energy lines identified as Nb-95 and Xe-131 are due to the lesser energy lines caused by uranium decay. We do not believe Nb-95 and Xe-131 are present at levels greater than the gamma scan detection limit as defined in Table 2.1, note (b), of the subject contract, for any of the samples listed. Therefore, when reporting the samples listed in Attachment 1, Nb-95 and Xe-131 will not be listed as detected. The samples will be reported with an XYZ comment code for the gamma scan analysis.

If you have any questions, please call me at (509)375-3131.

Sincerely,

Suzanne Root

Suzanne Root

CC: Richard Merrell
Van Pettey
Doug Swenson

RECEIVED

July 15, 1993

Attachment 1

PNL ID		WORKORDER #
B07CB1	Slurry Dup 2	W3-07-038-01
B07C09	Soil 1	W3-07-038-02
B07C10	Soil 2	W3-07-038-03
B07C11	Soil 3	W3-07-038-04
B07C14	Soil 6	W3-07-038-05
B07C15	Soil 7	W3-07-038-06
B07C16	Soil 8	W3-07-038-07
B07C17	Soil 9	W3-07-038-08
B07C18	Soil 10	W3-07-038-09
B07C19	Soil 11	W3-07-038-10
B07C20	Soil 12	W3-07-038-11
B07C21	Soil 13	W3-07-038-12
B07C22	Soil 14	W3-07-038-13
B07C23	Soil 15	W3-07-038-14
B07C24	Soil 16	W3-07-039-01
B07C25	Soil 17	W3-07-039-02
B07C26	Soil 18	W3-07-039-03
B07C27	Soil 19	W3-07-039-04
B07C28	Soil 20	W3-07-039-05
B07C29	Soil 21	W3-07-039-06
B07C30	Soil 22	W3-07-039-07
B07C31	Soil 23	W3-07-039-08
B07C32	Soil 24	W3-07-039-09
B07C38	Soil 30	W3-07-039-10
B07C39	Soil 31	W3-07-039-11
B07C40	Soil 32	W3-07-039-12
B07C43	Soil 35	W3-07-039-13
B07C44	Soil 36	W3-07-039-14

PNL ID		WORKORDER #
B07C45	Soil 37	W3-07-040-01
B07C46	Soil 38	W3-07-040-02
B07C55	Soil 47	W3-07-040-03
B07C56	Soil 48	W3-07-040-04
B07C57	Soil 49	W3-07-040-05
B07C58	Soil 50	W3-07-040-06
B07C67	Soil Dup 1	W3-07-040-07
B07C68	Soil Dup 2	W3-07-040-08
B07C91	Slurry 11	W3-07-040-09
B07C92	Slurry 12	W3-07-040-10
B07C93	Slurry 13	W3-07-040-11
B07C95	Slurry 15	W3-07-040-12
B07C96	Slurry 16	W3-07-040-13
B07C97	Slurry 17	W3-07-040-14
B07C77	Slurry 3	W3-07-084-01
B07C79	Slurry 5	W3-07-084-02
B07C80	Slurry 6	W3-07-084-03
B07C81	Slurry 7	W3-07-084-04

Westinghouse Hanford Company — **Internal Memo**

From: Geochemistry & Hydrochemistry
Phone: 376-3324
Date: December 1, 1993
Subject: DATA VALIDATION OF 300-FF-1 SOIL WASHING COLLECTED SEPTEMBER 1993

To: R. D. Belden

cc: J. C. Johnston
D. G. Horton

This report is to document the validation of 300-FF-1 Soil Washing data collected during September 1993. The validation was based on WHC-CM-7-8 manual "Environmental Engineering and Geotechnology Function Procedures" (WHC 1992) and the "Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1992" Appendix B DOE/RL-93-09 (DOE-RL, 1993a).

The data were collected, analyzed and processed in a similar manner as the Resource Conservation and Recovery Act (RCRA) groundwater monitoring projects. The analytical laboratories utilized were Datachem Laboratory, Salt Lake City Utah and International Technology Analytical Services, Richland, Washington. Data validation was performed by Ms. P.B. Freeman, RCRA Sampling and Analysis Task Leader. A electronic copy of the data is provide in both paradox and lotus format. Hardcopies of data were provided prior to this report.

Data validation consisted of seven parts:

a. 100% verification that requested data were received.
b. 100% verification that holding times were meet.
c. 100% evaluation of precision with field duplicates
d. 100% evaluation of potential sample contamination with field blank data.
e. 100% evaluation of laboratory MS/MSD and surrogate data through laboratory incident reports.
f. 100% evaluation of laboratory blanks.
g. 100% evaluation of data completeness.

The outcome of the validation:
Part a: All data requested were received.
Part b: All analytical holding times were meet.

Part c:
Evaluation of Duplicate data was performed using procedure 2.1 "Evaluation of RCRA Groundwater Field Duplicate and Blank Sample Data" (WHC 1992) and using Appendix B (DOE-RL 1993).

There were two duplicate pairs evaluated. The paired sample numbers are B07DX9 with B07DQ5 and B07DX8 with B07DQ4, respectfully. The evaluation of B07DX9 and B07DQ5 resulted in three constituents which exceeded a required 25% relative percentage difference (WHC 1992) and were above the limit of detection as defined in Appendix B (DOE-RL 1993). The three constituents are copper, potassium and silver. All of these were analyzed by ICP metal method SW-846 6010.

The evaluation of B07DX8 and B07DQ4 resulted in twelve constituents which exceeded a required 25% relative percentage difference (WHC 1992) and were above the limit of detection as defined in Appendix B (DOE-RL 1993). The twelve constituents are: total uranium, tetrahydrofuran, barium, calcium, copper, magnesium, manganese, potassium, silver, sodium, zinc and lead. Uranium was analyzed by an inhouse method. Tetrahydrofuran was analyzed by method SW-846 8240. Lead was analyzed by method SW-846 7421 and the rest were analyzed by method SW-846 6010.

As a result of this evaluation all data associated with these sample numbers and constituents are flagged with a validation flag of Q. The Q-flagged data can be used qualitatively, but not regulatory decisions should be made based on a single flagged data point.

Part d: Evaluation of field blank data was performed using procedure 2.1 "Evaluation of RCRA Groundwater Field Duplicate and Blank Sample Data" (WHC 1992) and using Appendix B (DOE-RL 1993).

There were two water blanks and two soil blanks collected during the September 1993 sampling. The blanks exceeding two times the method detection limit (MDL) were flagged with a Q (WHC 1992). MDL are defined in Appendix B (DOE-RL 1993). The sample numbers for the water blanks are B07DY0 and B07DY1. Each sample had one the same constituent exceed two times the MDL. The constituent was barium which is analyzed by method SW-846 6010. The sample numbers for the soil blanks are B07DY5 and B07DY6. Each sample had the same six constituents exceed two times the MDL. The constituents were aluminum, iron, magnesium, manganese, barium and calcium. These constituents were analyzed by method SW-846 6010.

As a result of this evaluation the above constituents associated with the collect and analyze dates of these sample numbers and constituents are flagged with a validation flag of Q. The Q-flagged data can be used qualitatively, but not regulatory decisions should be made based on a single flagged data point.

Part e: There were not laboratory incident reports for this data. Therefore, no matrix spike, matrix spike duplicate or surrogate samples associated with these samples exceeded laboratory acceptance criteria.

Part f: There were no "B" qualifiers associated with these data, therefore no laboratory blanks exceeded laboratory acceptance criteria.

Part g: The data completeness is determined after data validation is completed and is calculated by the number of unflagged divided by the total number of validated data expressed as a percentage. The RCRA using a 80% acceptance guidance. The total number of soil data are 1122 constituents and water data are 683 constituents. The total unflagged soil data are 918 constituents and water data are 639 constituents. The calculated completeness for soil and water data are 82% and 93%, respectfully. These data are within acceptable completeness criteria.

References:

DOE-RL, 1993, Annual Report for RCRA Groundwater monitoring Projects at Hanford Site Facilities for 1992, DOE/RL-93-09, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC, 1992, Environmental Engineering and Geotechnology Function Procedures, WHC-CM-78, vol. 4, Westinghouse Hanford Company, Richland, Washington.

P. B. Freeman

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