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**FIELD STUDY OF DISPOSED WASTES
FROM ADVANCED COAL PROCESSES
DE-AC21-86MC22118
DOE Quarterly Technical
Progress Report**

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1.0 OBJECTIVES

The Department of Energy/Morgantown Energy Technology Center (DOE/METC) has initiated research on the disposal of solid wastes from advanced coal processes. The objective of this research is to develop information to be used by private industry and government agencies for planning waste disposal practices associated with advanced coal processes. To accomplish this objective, DOE has contracted Radian Corporation and the North Dakota Energy & Environmental Research Center (EERC) to design, construct, and monitor a limited number of field disposal tests with advanced coal process wastes. These field tests will be monitored over a three year period with the emphasis on collecting data on the field disposal of these wastes.

There has been considerable research on the characteristics and laboratory leaching behavior of coal wastes--a lesser amount on wastes from advanced coal processes. However, very little information exists on the field disposal behavior of these wastes. Information on field disposal behavior is needed (a) as input to predictive models being developed, b) as input to the development of rule of thumb design guidelines for the disposal of these wastes, and c) as evidence of the behavior of these wastes in the natural environment.

2.0 SUMMARY OF PREVIOUS WORK

This study is organized into four major Tasks. Tasks 1 and 2 were devoted to planning the Task 3 field study. Task 4 uses the results of the field testing to produce an Engineering Design Manual for the utilities and industrial users who manage wastes from advanced coal combustion technologies.

Task 1 identified and rated test design options. A Test Design Manual was prepared and submitted to METC in 1988. Specific test procedures suitable for each design option were identified under Task 2. These test methods were documented in a

Test Procedures Manual, submitted to METC in 1988. Also under Task 2, test sites were selected and site access was negotiated. Sites in Illinois and North Dakota were delayed at this stage, and the North Dakota site was dropped from consideration. Task 2 was completed and Final Test Plans were submitted to METC for three sites in 1988.

Task 3 progress for each of the test sites is summarized below:

2.1   Colorado

The test cell was constructed in June, 1989 with CFBC ash from a low sulfur western coal. The ash has low lime and sulfate content. Core samples were collected in June and December 1989, in March, June and December of 1990, in June 1991, and most recently in June 1992. No groundwater or porewater samples have been recovered; two surface runoff samples were collected. At this time the three year monitoring period at the Colorado site is completed. The DOE plans further field monitoring at this site on an annual basis. A draft site assessment report, based on the initial three years of monitoring, was completed in December, 1992.

The strength of core samples from the Colorado site is low to moderate (200 psi to 900 psi), with permeabilities of 2×10^{-3} to 3×10^{-4} . Laboratory leachates show moderate concentrations of calcium, sulfate, and other common ions. Trace element concentrations in test leachates are low compared to regulatory limits. No leachate has been generated from the test cell at this site.

2.2   Ohio

Two test cells were constructed, in February and April of 1989, using LIMB ash from an Ohio coal with 2.4% sulfur. The ash has a high lime and sulfate content. Test case 1 (north cell) was constructed with 25% moisture; test case 2 (south cell) was constructed with 38% moisture to optimize compaction. The wastes expanded, heaved,

and fractured during the first year, particularly in the south cell. Mineralogical changes in the wastes with hydration and weathering are the primary cause. Core strength is low to moderate (<100 psi to 2000 psi) and highly variable because of fracturing. Field measurements of permeability vary from 3×10^{-3} to 5×10^{-5} cm/sec. Permeabilities are lowest in the north cell.

Large amounts of water were bound in the wastes in the first year as the waste saturated and hydrated. Starting in the second year, leachate appears to have migrated out of the south cell into one downgradient well. The leachate at the bottom of the test cell contains up to several thousand mg/L of sulfate, chloride, potassium, and sodium, with somewhat lower concentrations of calcium and silicon. Trace metal concentrations are generally low compared to regulatory limits, but a few samples contain arsenic at concentrations of up to 0.35 mg/L.

Core samples were first collected in June, 1989, and quarterly and annual core sampling events have taken place according to schedule since that time. Water samples have been collected on a quarterly basis since October, 1989. Final core sampling for the three year monitoring period took place in August, 1992. A final site report is in preparation. Further monitoring, on an annual basis, is planned by the DOE.

2.3   Illinois

The first Illinois test cell was completed in April, 1991, with BFBC ash from a Illinois coal with 3.1% sulfur. A large excess of limestone is used in the combustor; the ash is high in lime relative to most FBC wastes, containing up to 30% CaO. The ash also contains abundant sulfate, but has relatively low concentrations of typical coal ash constituents compared to other wastes included in this study. The two test cells planned for the second Illinois test case will evaluate the effects of added coal ash on cementitious reactions in the waste. Laboratory studies to define the optimum

mix of FBC waste and coal fly ash are completed. Cell construction, planned for late fall, 1992, has been delayed until May, 1993 because of permit complications.

The initial cell was instrumented and sampled in June 1991. Water samples and additional cores were collected in August and November, 1991, and February and May, 1992. No expansion has been noted at the site. The wastes are solidified with unconfined compressive strength between approximately 150 and 550 psi, although some fracture zones may be present in the waste and may reduce overall strength. The permeability measured on cores recovered from the test cell ranges from 1×10^{-6} to 2×10^{-4} ; field permeability measurements range from a high of 3×10^{-3} near the surface to a low of 2×10^{-5} at depth in the test cell.

3.0 OBJECTIVES FOR THE CURRENT REPORTING PERIOD

The specific objectives for the reporting period of January, 1993 to March, 1993 were as follows:

- Finalize plans for continued monitoring at the Ohio and Colorado sites;
- Collect and analyze seventh quarterly water samples from the first Illinois test case;
- Begin construction of the second Illinois test case, dependant on permit approval and weather conditions;
- Continue production of a short video presentation on the advanced coal wastes test program;
- Load EERC data onto the project database and report as available; and
- Prepare the Final Case Report on the Ohio test case.

4.0 ACTIVITIES FOR THE REPORTING PERIOD

4.1 Colorado Ute Site

A cost proposal for continued annual monitoring at the Colorado site was submitted to DOE/METC. The draft Final Site Report will be completed as a final document and data delivered in electronic format pending receipt of comments on the draft document from the DOE.

4.2 Ohio Site

A cost proposal for continued annual monitoring at the Ohio site was submitted to the DOE. The draft Final Site Report is in preparation. Delivery of the draft report is planned prior to the site review meeting to be held in Morgantown on May 21, 1993.

4.3 Illinois site

The seventh set of quarterly water samples was collected in February, 1993. The analytical results for these water samples are shown in Table 1. Major element concentrations in groundwater samples from upgradient and downgradient monitoring wells at the Illinois site are illustrated in Figures 1 and 2. The upgradient concentrations of the major analytes calcium, magnesium, sulfate, and alkalinity are highly variable with depth and over time, especially for the shallow well, ILMW-3. Variability of these analytes in the downgradient wells is much lower. In the downgradient wells the concentrations of all analytes except alkalinity are highest in the shallowest well. Upgradient and downgradient concentrations of the major analytes in the shallow wells are comparable. The concentrations of calcium, magnesium, and sulfate are consistently higher in the upgradient mid-depth well, ILMW-2, than in the downgradient mid-depth well, ILMW-5.

Figure 1. Major cations in groundwater from upgradient and downgradient of the Illinois FBC ash test cell.

Figure 2. Major anions in groundwater from upgradient and downgradient of the Illinois FBC ash test cell.

The other major ions, sodium and chloride, show little variation in concentration with depth. Sodium concentrations remain relatively stable over the monitoring period, while the chloride concentration in both upgradient and downgradient locations was much higher in the initial samples than in any subsequent samples. There is no obvious explanation for this trend. Contamination could have occurred, but the consistency of this pattern in all wells but ILMW-5, and the lack of a similar trend in any of the major cations, suggests that this is not the case.

4.3.1 Porewater Chemistry

Ten of the lysimeters installed in the Illinois site yielded sufficient sample for complete analysis this quarter. The porewater samples collected within the ash are characterized by a pH of 11.2 to almost 12.8. These samples contain less than 100 mg/L of calcium, except for the sample from ILLY26. Sulfate concentrations range from 770 to 6000 mg/L, and potassium and sodium range up to 4800 mg/L and 4700 mg/L respectively. Dissolved silicon concentrations in the porewaters vary widely, from 1 mg/L to 2000 mg/L. Total alkalinities are often very high, ranging up to 240 meq/L (14,640 mg/L as HCO_3). The top portion of Figure 3 shows the average concentrations in seventh quarter porewater samples from three depth ranges in the test cell. All depths are relative to the top of the ash, which is presently covered by two feet of vegetated soil. Most of the major analytes shown have a similar distribution; concentrations in the surface zone are generally lower than at the mid depths, and concentrations just above the base of the test cell at 7.5 feet are lower than at five feet. Silicon concentrations show a different distribution, with the lowest concentration at the five foot depth.

The bottom portion of Figure 3 shows concentration trends over time for porewater samples from the surface zone of the test cell. This is the only zone from which samples have been consistently recovered. Concentrations of all samples collected from the 1 foot depth during each sampling event were averaged for this figure.

Figure 3. Major ions in porewater from the Illinois FBC ash test cell. The top graph shows average results from Event 7 (Feb. 1993) samples versus depth; three samples were collected from 1 foot, two from 4 to 6 feet, and five from 6 to 8 feet depth. The bottom graph shows average properties of samples from 1 foot depth for all sampling events where porewater samples were collected.

Concentrations of all elements except sodium are lower in the seventh quarter (Feb. 1993) samples than in the third quarter (Feb. 1992) samples. The average near-surface concentrations of all analytes except conductivity increase between the third and fourth quarters (Feb. to May, 1992), drop in the fifth quarter (Aug. 1992), then increase again in following quarters. The average conductivity peaks in the fourth quarter and decreases in all subsequent measurements. This pattern is consistent with the wash-out of soluble ions over time which was seen in the Ohio test cells.

5.0 ACTIVITIES PLANNED FOR THE NEXT QUARTER

The following activities are planned for the period of April, 1993 through June 1993:

- A meeting is scheduled for May 21 in Morgantown to discuss Ohio site results and general progress on the project;
- A draft of the Ohio Final Site Report will be submitted to the DOE;
- Year 4 funding for continued monitoring at the Ohio and Colorado site will be finalized; and
- The Illinois Test Case 5 construction will begin.

Table 1

Chemical Characteristics of Liquid from Illinois, Event 7

Parameter	Site ID / Location ID			
	Sample ID		Log Date	
	IL / ILM01	IL / ILM02	IL / ILM03	IL / ILM04
Units	IL137	IL138	IL139	IL140
	3/01/93	3/01/93	3/01/93	3/01/93
Anions				
Chloride	26	13	21	17
	(0.052)	(0.026)	(0.052)	(0.052)
Fluoride	ND	0.16 $\emptyset$	0.21 $\emptyset$	0.24 $\emptyset$
	(0.10)	(0.10)	(0.10)	(0.10)
Sulfate	1200	1600	410	360
	(5.0)	(2.5)	(0.50)	(1.0)
Elements by ICPEs or AA				
Aluminum	ND	ND	ND	ND
	(0.20)	(0.20)	(0.20)	(0.20)
Arsenic	ND	ND	ND	ND
	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Barium	0.073	ND	0.025 $\emptyset$	0.016 $\emptyset$
	(0.010)	(0.010)	(0.010)	(0.010)
Beryllium	ND	ND	ND	ND
	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Boron	ND	ND	1.3 $\emptyset$	1.3 $\emptyset$
	(0.60)	(0.60)	(0.60)	(0.60)
Cadmium	ND	ND	ND	ND
	(0.0010)	(0.0010)	(0.0010)	(0.0010)
Calcium	560	460	170	150
	(5.0)	(5.0)	(5.0)	(5.0)
Chromium	ND	ND	ND	ND
	(0.010)	(0.010)	(0.010)	(0.010)
Cobalt	ND	ND	ND	0.016 $\emptyset$
	(0.010)	(0.010)	(0.010)	(0.010)
Copper	ND	ND	ND	ND
	(0.020)	(0.020)	(0.020)	(0.020)
Iron	ND	0.21 $\emptyset$	0.75	0.49
	(0.050)	(0.050)	(0.050)	(0.050)
Lead	ND	ND	ND	ND
	(0.0030)	(0.0030)	(0.0030)	(0.0030)
Magnesium	80	240	93	81
	(5.0)	(5.0)	(5.0)	(5.0)
Manganese	0.41	0.63	1.2	0.35
	(0.010)	(0.010)	(0.010)	(0.010)
Mercury	ND	ND	ND	NA
	(0.00018)	(0.00018)	(0.00018)	(0.00018)
Molybdenum	ND	ND	ND	ND
	(0.050)	(0.050)	(0.050)	(0.050)
Nickel	ND	0.035 $\emptyset$	0.30	ND
	(0.020)	(0.020)	(0.020)	(0.020)
Potassium	15	ND	7.5 $\emptyset$	7.2 $\emptyset$
	(3.0)	(3.0)	(3.0)	(3.0)
Selenium	ND	ND	ND	ND
	(0.0050)	(0.0050)	(0.0050)	(0.0050)
Silicon	4.6 $\emptyset$	6.7	6.9	7.1
	(1.0)	(1.0)	(1.0)	(1.0)
Silver	ND	ND	ND	ND
	(0.010)	(0.010)	(0.010)	(0.010)
Sodium	60	54	110	160
	(5.0)	(5.0)	(5.0)	(5.0)
Strontium	3.0	0.83	1.5	1.6
	(0.0030)	(0.0030)	(0.0030)	(0.0030)
Tin	ND	ND	ND	ND
	(0.60)	(0.60)	(0.60)	(0.60)

( ) = Detection Limit   ND = Not Detected   NA = Not Analyzed $\emptyset$ = < 5X Det. Limit

C1-1

Table 1

(Continued)

Parameter	Units	Site ID / Location ID			
		Sample ID	Log Date	Sample ID	Log Date
		IL / ILMW01	IL / ILMW02	IL / ILMW03	IL / ILMW04
		IL137	IL138	IL139	IL140
		3/01/93	3/01/93	3/01/93	3/01/93
Elements by ICPES or AA, cont.					
Vanadium	mg/L	ND	ND	ND	ND
Zinc	mg/L	ND	ND	0.10	0.028 θ
Field measurements					
Alkalinity	meq/L	4.34	10.2	12.4	14.68
Conductivity	umhos/cm	2800	3250	2075	1890
Filterable Residue	mg/L	2737	3245	1337	1340
Redox (Eh)	mV	-26.9	9.6	8.7	5.8
Temperature	deg. C	10.7	12.6	13.4	12.5
pH	pH units	7.28	6.64	6.63	6.69

( ) = Detection Limit   ND = Not Detected   MA = Not Analyzed θ = < 5X Det. Limit

C1-2

Table 1
(Continued)

Parameter	Units	Site ID / Location ID			
		Sample ID		Log Date	
		IL / ILMW04 IL147 Dup of IL140 3/01/93	IL / ILMW05 IL141 3/01/93	IL / ILMW06 IL142 3/01/93	IL / ILMW07 IL143 3/01/93
Anions					
Chloride	mg/L	18 (0.052)	17 (0.052)	19 (0.052)	36 (0.13)
Fluoride	mg/L	0.24 @ (0.10)	0.23 @ (0.10)	0.12 @ (0.10)	0.34 @ (0.10)
Sulfate	mg/L	350 (0.50)	370 (0.50)	2000 (5.0)	220 (0.25)
Elements by ICPES or AA					
Aluminum	mg/L	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
Arsenic	mg/L	ND (0.0040)	0.012 @ (0.0040)	ND (0.0040)	ND (0.0040)
Barium	mg/L	0.016 @ (0.010)	0.015 @ (0.010)	0.011 @ (0.010)	0.028 @ (0.010)
Beryllium	mg/L	ND (0.0020)	ND (0.0020)	ND (0.0020)	ND (0.0020)
Boron	mg/L	1.4 @ (0.60)	1.4 @ (0.60)	1.1 @ (0.60)	1.7 @ (0.60)
Cadmium	mg/L	ND (0.0010)	ND (0.0010)	ND (0.0010)	ND (0.0010)
Calcium	mg/L	150 (5.0)	160 (5.0)	530 (5.0)	110 (5.0)
Chromium	mg/L	ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)
Cobalt	mg/L	ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)
Copper	mg/L	ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)
Iron	mg/L	0.68 (0.050)	0.74 (0.050)	ND (0.050)	1.6 (0.050)
Lead	mg/L	ND (0.0030)	ND (0.0030)	ND (0.0030)	ND (0.0030)
Magnesium	mg/L	90 (5.0)	84 (5.0)	380 (5.0)	59 (5.0)
Manganese	mg/L	0.35 (0.010)	0.37 (0.010)	1.7 (0.010)	0.30 (0.010)
Mercury	mg/L	NA	NA	NA	ND (0.00018)
Molybdenum	mg/L	ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)
Nickel	mg/L	ND (0.020)	ND (0.020)	0.022 @ (0.020)	ND (0.020)
Potassium	mg/L	7.0 @ (3.0)	7.5 @ (3.0)	17 (3.0)	5.8 @ (3.0)
Selenium	mg/L	ND (0.0050)	ND (0.0050)	ND (0.0050)	ND (0.0050)
Silicon	mg/L	7.0 (1.0)	7.2 (1.0)	6.9 (1.0)	7.6 (1.0)
Silver	mg/L	ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)
Sodium	mg/L	160 (5.0)	160 (5.0)	140 (5.0)	140 (5.0)
Strontium	mg/L	1.6 (0.0030)	1.7 (0.0030)	3.6 (0.0030)	1.2 (0.0030)
Tin	mg/L	ND (0.60)	ND (0.60)	ND (0.60)	ND (0.60)

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5x Det. Limit

CI-3

Table 1

(Continued)

Parameter	Site ID / Location ID			
	Sample ID		Log Date	
	IL / ILMW04	IL / ILMW05	IL / ILMW06	IL / ILMW07
	IL147 Dup of IL140	IL141	IL142	IL143
	3/01/93	3/01/93	3/01/93	3/01/93

Elements by ICPEs or AA, cont.				
Vanadium	ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)
Zinc	ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)

Field measurements				
Alkalinity	14.52 (.03)	14.6 (.03)	14.84 (.03)	12.48 (.03)
Conductivity	1830 (5)	1890 (5)	3440 (5)	1950 (5)
Filterable Residue	1287 (1)	1379 (1)	4329 (1)	1011 (1)
Redox (Eh)	6.7 (1)	11.5 (1)	22.0 (1)	6.0 (1)
Temperature	12.5 (1)	12.8 (1)	12.8 (1)	13.1 (1)
pH	6.65 (1)	6.59 (1)	6.42 (1)	6.69 (1)

( ) = Detection Limit   ND = Not Detected   NA = Not Analyzed   @ = < 5X Det. Limit

CJ-4

Table 1
(Continued)

Site ID / Location ID									
Sample ID									
Log Date									
IL / ILMW08									
IL / ILMW09									
IL / ILBLNK									
IL / ILLY05									
IL144									
IL145									
IL146									
IL152									
3/01/93									
3/01/93									
3/01/93									
Units									
Parameter									

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5X Det. Limit

Table 1
(Continued)

Parameter	Site ID / Location ID			
	Sample ID		Log Date	
	IL / ILMW08 IL144 3/01/93	IL / ILMW09 IL145 3/01/93	IL / ILBLNK IL146 3/01/93	IL / ILLY05 IL152 3/04/93

Elements by ICPEs or AA, cont.				
Vanadium	mg/L	ND (0.020)	ND (0.020)	ND (0.020)
Zinc	mg/L	ND (0.020)	0.026 @ (0.020)	0.18 (0.020)
Field measurements				
Alkalinity	meq/L	11.44 (.03)	13.16 (.03)	.032 (.03)
Conductivity	umhos/cm	3140 (5)	4180 (5)	29 (5)
Filterable Residue	mg/L	3287 (1)	5610 (1)	ND (1)
Redox (Eh)	mV	10.8 (1)	25.1 (1)	-38.9 (1)
Temperature	deg. C	11.8 (1)	9.7 (1)	23.7 (1)
pH	pH units	6.61 (1)	6.34 (1)	7.31 (1)

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5X Det. Limit

C1-6

Table 1
(Continued)

Site ID / Location ID					
Parameter	Sample ID		Log Date		
	IL / ILLY19	IL / ILLY23	IL / ILLY13	IL / ILLY16	
	IL158	IL159	IL163	IL164	
	3/04/93	3/04/93	3/04/93	3/04/93	
Units					

Anions					
Chloride	66	140	330	870	(5.2)
Fluoride	0.15 @	ND	0.35 @	0.39 @	(0.10)
Sulfate	920	1300	3400	6000	(10)

Elements by ICPEs or AA					
Aluminum	ND	ND	0.93 @	1.3	(0.20)
Arsenic	ND	ND	ND	ND	(0.0040)
Barium	ND	ND	ND	ND	(0.010)
Beryllium	ND	ND	ND	ND	(0.0020)
Boron	ND	ND	ND	ND	(0.60)
Cadmium	ND	ND	ND	ND	(0.0010)
Calcium	17	5.3	ND	1.6 @	(1.0)
Chromium	0.020 @	ND	ND	0.034 @	(0.010)
Cobalt	ND	ND	ND	ND	(0.010)
Copper	ND	ND	ND	ND	(0.020)
Iron	2.0	ND	ND	0.073 @	(0.050)
Lead	ND	ND	ND	ND	(0.0030)
Magnesium	ND	ND	ND	ND	(1.0)
Manganese	ND	ND	ND	ND	(0.010)
Molybdenum	0.21 @	0.56	0.98	1.3	(0.050)
Nickel	2.5	ND	ND	ND	(0.020)
Potassium	150	890	3200	4200	(30)
Selenium	ND	ND	ND	ND	(0.0050)
Silicon	330	560	2000	570	(1.0)
Silver	ND	ND	ND	ND	(0.010)
Sodium	650	1000	2300	3600	(20)
Strontium	5.9	7.4	0.095	0.46	(0.0030)
Tin	ND	ND	ND	ND	(0.60)
Vanadium	0.020 @	ND	0.070 @	0.064 @	(0.020)

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5X Det. Limit

Table 1
(Continued)

Parameter	Units	Site ID / Location ID			
		IL / ILLY19	IL / ILLY23	IL / ILLY13	IL / ILLY16
		IL158	IL159	IL163	IL164
		3/04/93	3/04/93	3/04/93	3/04/93

Elements by ICPEES or AA, cont.					
Zinc	mg/L	ND	ND	0.023 @ (0.020)	0.026 @ (0.020)
Field measurements					
Alkalinity	meq/L	16.48	41	131.48	187.76
Conductivity	umhos/cm	ND	7580	15770	21000
Filterable Residue	mg/L	3224	6010	18445	31019
Redox (Eh)	mV	-261.7	-309.9	-327.5	-326.2
Temperature	deg. C	8.7	10.2	9.1	10.9
pH	pH units	11.60	12.39	12.71	12.68
		( )	( )	( )	( )

( ) = Detection Limit   ND = Not Detected   NA = Not Analyzed   @ = < 5X Det. Limit

Table 1
(Continued)

Site ID / Location ID						
		Sample ID				
		Log Date				

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5X Det. Limit C1-9

Table 1
(Continued)

Site ID / Location ID				
Sample ID				
Log Date				
Parameter	IL / ILLY17 IL165 3/04/93	IL / ILLY22 IL166 3/04/93	IL / ILLY25 IL167 3/04/93	IL / ILLY26 IL168 3/04/93
Units				

Elements by ICPES or AA, cont.				
Zinc	ND	ND	0.022 @	ND
	(0.020)	(0.020)	(0.020)	(0.020)
Field measurements				
Alkalinity	240.32	NA	33.4	43.76
Conductivity	30000	9760	5990	10230
Filterable Residue	NA	NA	NA	5623
Redox (Eh)	-330.6	-311.6	-247.9	-321.6
Temperature	10.8	12.5	7.6	12.1
pH	12.78	12.37	11.39	12.47
	( )	( )	( )	( )

( ) = Detection Limit   ND = Not Detected   NA = Not Analyzed   @ = < 5X Det. Limit   C1-10

Table 1
(Continued)

Site ID / Location ID
Sample ID
Log Date

IL / ILLY27
ILL169
3/01/93

Parameter Units

Anions
Chloride mg/L 330 (1.3)
Fluoride mg/L 0.17 @ (0.10)
Sulfate mg/L 2700 (2.5)

Elements by ICPEs or AA

Aluminum mg/L ND (0.20)
Arsenic mg/L ND (0.0040)
Barium mg/L ND (0.010)
Beryllium mg/L ND (0.0020)
Boron mg/L ND (0.60)
Cadmium mg/L ND (0.0010)
Calcium mg/L ND (5.0)
Chromium mg/L 0.015 @ (0.010)
Cobalt mg/L ND (0.010)
Copper mg/L ND (0.020)
Iron mg/L ND (0.050)
Lead mg/L ND (0.0060)
Magnesium mg/L ND (5.0)
Manganese mg/L ND (0.010)
Molybdenum mg/L 0.76 (0.050)
Nickel mg/L ND (0.020)
Potassium mg/L 1900 (30)
Selenium mg/L ND (0.0050)
Silicon mg/L 1400 (1.0)
Silver mg/L ND (0.010)
Sodium mg/L 1900 (5.0)
Strontium mg/L 0.27 (0.0030)
Tin mg/L ND (0.60)
Vanadium mg/L 0.042 @ (0.020)

( ) = Detection Limit ND = Not Detected NA = Not Analyzed @ = < 5X Det. Limit

C1-11

Table 1
(Continued)

Site ID / Location ID
Sample ID
Log Date

Parameter	Units	IL / ILLY27 IL169 3/01/93
Elements by ICPEs or AA, cont.		
Zinc	mg/L	ND (0.020)
Field measurements		
Alkalinity	meq/L	73.12 (.03)
Conductivity	umhos/cm	1100 (5)
Filterable Residue	mg/L	2562 (1)
Redox (Eh)	mV	-303.6 (1)
Temperature	deg. C	11.8 (1)
pH	pH units	12.25 (1)

( ) = Detection Limit   ND = Not Detected   NA = Not Analyzed   Ø = < 5X Det. Limit

**DATE
FILMED**

10/04/93

END