RS-8525-06

Project No. 80-022

Jan. 81

IL-0407-11

CANONIE D'APPOLONIA

EPA Region 5 Records Ctr.

291083

Test Results

Disposal Site Closure

River Front Disposal Site
Wood River , Illinois

Amoco Oil Company
Wood River, Illinois

Test Results

Disposal Site Closure

CANONIE
D'APPOLONIA

TEST RESULTS
DISPOSAL SITE CLOSURE
RIVERFRONT DISPOSAL SITE
WOOD RIVER, ILLINOIS

Present herein are the results of field and laboratory tests conducted by Canonie D'Appolonia Company to establish design parameters for the impoundment improvements planned by the AMOCO Oil Company at its Riverfront Disposal site in Wood River, Illinois. Detailed discussion of the design is presented in the Data and Design Report.

Respectfully submitted,

Richard F. Brissette
President, Canonie D'Appolonia Company

80022
January, 1981

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D'APPOLONIA

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TABLE 1

RESULTS OF WATER QUALITY DETERMINATIONS
FOR SELECTED PARAMETERS AT ALL SAMPLING STATIONS

SAMPLING STATION(1)	PARAMETER(2)					
	pH (pH Units)	ACIDITY (mg/l $CaCO_3$)	ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm @ 25°C)	CHLORIDE (mg/l)	SULFATE (mg/l)
Impounded Surface Waters:						
Pond 1A	7.65	<2	442	1120	84	26
Pond 1B	7.30	<2	290	874	65	55
Pond 3	7.25	<2	252	1250	120	170
Shallow Aquifer Groundwaters:						
P-1S	5.90	<2	310	2920	640	40
P-2S	6.98	<2	980	2290	89	110
P-5S	7.21	<2	582	3940	190	1150
P-6S	10.57	0	7480	35300	5200	5000
P-9S	6.84	<2	802	1930	120	15
P-12S	8.80	0	1820	13200	2400	5000
P-14S	6.40	<2	550	3570	470	20
P-15S	7.80	0	1620	5820	860	600
P-16S	6.40	<2	1380	10500	2600	<1
Lower Aquifer Groundwaters:						
P-1	6.30	<2	448	832	6	4
P-2	7.01	<2	326	731	42	15
P-3	6.80	<2	320	912	59	30
P-4	6.40	<2	502	3010	430	200
P-5	6.98	<2	290	1640	96	280
P-6	6.95	<2	388	1260	64	60
P-7	6.40	<2	602	2350	380	110
P-8	6.90	<2	208	465	25	14
P-9	6.95	<2	264	655	32	4
P-12	6.70	<2	278	706	38	6
P-13	6.60	<2	566	1510	160	10
P-15	6.00	<2	804	2380	300	30
P-16	6.10	<2	1320	10800	3000	300

(1)See Figure 1 for sampling station locations.
(2)Analytical determinations were made in accordance with the U.S. EPA (1979) or APHA (1976).

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TABLE 2

RESULTS OF INORGANIC WATER QUALITY DETERMINATIONS[1]

PARAMETER[2]	UNITS	IMPOUNDED SURFACE WATER			SHALLOW AQUIFER SAMPLING STATIONS				LOWER AQUIFER SAMPLING STATIONS				U.S. EPA NATIONAL INTERIM PRIMARY DRINKING WATER STANDARDS[3]	U.S. EPA PROPOSED NATIONAL SECONDARY DRINKING WATER STANDARDS[4]
		POND 1A	POND 1B	POND 3	P-2S	P-5S	P-6S	P-9S	P-2	P-5	P-6	P-9	MAXIMUM LEVEL	MAXIMUM LEVEL[5]
pH	pH units	7.65	7.30	7.25	6.98	7.21	10.57	6.84	7.01	6.98	6.95	6.95	-[6]	6.5-8.5
Specific Conductance	µmhos/cm @ 25°C	1,120	874	1,250	2,290	3,940	35,300	1,930	731	1,640	1,260	655	-	-
Acidity	mg/ℓ $CaCO_3$	<2	<2	<2	<2	<2	0	<2	<2	<2	<2	<2	-	-
Alkalinity	mg/ℓ $CaCO_3$	442	290	252	980	582	7,480	802	326	290	388	264	-	-
Chloride	mg/ℓ	84	65	120	89	190	5,200	120	42	96	64	32	-	250.0
Fluoride	mg/ℓ	2.87	1.04	1.88	0.42	0.28	1.32	0.37	0.25	0.39	0.28	0.32	1.4-2.4[7]	-
Nitrate	mg/ℓ N	0.5	0.3	1.1	0.1	0.2	100	0.2	<0.1	<0.1	0.1	0.9	10.0	-
Sulfate	mg/ℓ	26	55	170	110	1,150	5,000	15	15	280	60	4	-	250.0
Total Organic Carbon	mg/ℓ	622	510	1,170	113	127	18,700	480	251	70	7	12	-	-
Chemical Oxygen Demand	mg/ℓ	450	760	5,000	1,900	600	52,000	510	210	170	870	65	-	-
Hardness (Calculated)	mg/ℓ $CaCO_3$	590	410	590	1,000	1,800	110	820	340	590	440	270	-	-
Dissolved Metals[8]:														
Aluminum	mg/ℓ	8.2	2.3	3.4	<0.1	0.2	0.9	0.2	<0.1	<0.1	<0.1	<0.1	-	-
Antimony	mg/ℓ	<0.3	<0.1	<0.3	<0.1	<0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Arsenic	mg/ℓ	0.009	0.004	0.015	0.001	<0.001	3.60	<0.001	<0.001	<0.001	0.004	0.002	0.05	-
Barium	mg/ℓ	0.20	0.25	0.33	0.18	0.08	0.87	0.76	0.47	0.04	0.29	0.27	1.0	-
Beryllium	mg/ℓ	<0.3	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Cadmium	mg/ℓ	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	-
Calcium	mg/ℓ	130	96	140	230	510	36	200	87	170	110	68	-	-
Chromium	mg/ℓ	0.017	0.002	0.025	0.002	0.002	0.170	0.003	<0.001	<0.001	<0.001	0.002	0.05	-
Copper	mg/ℓ	<0.03	<0.01	<0.03	<0.01	0.01	0.14	<0.01	<0.01	<0.01	<0.01	<0.01	-	1.0
Iron	mg/ℓ	13	2.5	14	0.8	<0.1	6.6	<0.1	0.4	0.2	1.0	0.4	-	0.3
Lead	mg/ℓ	0.39	0.02	1.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	-
Magnesium	mg/ℓ	53	36	45	100	120	0.2	72	28	42	38	23	-	-
Manganese	mg/ℓ	1.8	0.9	3.4	16	16	0.3	7.9	1.3	2.3	3.4	1.0	-	0.05
Mercury	mg/ℓ	<0.0017	<0.0005	<0.0017	0.0011	<0.0005	<0.0020	<0.0005	<0.0005	0.0268	<0.0005	<0.0005	0.002	-
Nickel	mg/ℓ	<0.3	<0.1	<0.3	<0.1	0.4	5.6	<0.1	<0.1	0.6	<0.1	<0.1	-	-
Potassium	mg/ℓ	6.2	3.4	6.0	2.4	17	1.1	5.4	4.9	3.1	5.4	3.0	-	-
Selenium	mg/ℓ	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	-
Silicon	mg/ℓ	13	11	13	14	15	280	15	11	11	13	13	-	-
Silver	mg/ℓ	<0.001	<0.001	<0.001	<0.001	<0.001	0.16	<0.001	<0.001	<0.001	<0.001	<0.001	0.05	-
Sodium	mg/ℓ	71	35	66	95	170	8,900	98	22	67	58	51	-	-
Thallium	mg/ℓ	<3	1	3	6	13	83	5	<1	3	2	2	-	-
Tin	mg/ℓ	<3	<1	<3	<1	<1	<1	<1	<1	<1	<1	<1	-	-
Vanadium	mg/ℓ	<0.3	<0.1	<0.3	<0.1	<0.1	7.0	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Zinc	mg/ℓ	2.0	0.81	0.97	<0.01	0.04	2.9	0.04	0.02	0.13	<0.01	<0.01	-	5.0

(1) See Figure 1 for sampling station locations.

(2) Analytical determinations were in accordance with the U.S. EPA (1979) or APHA (1976).

(3) U.S. EPA, 1975, 40 CFR, Part 141.

(4) U.S. EPA, 1977, 40 CFR, Part 143, Federal Register, Vol. 42, No. 62, pp. 17143-17147.

(5) These standards need not be legally met at this time.

(6) "-" indicates no standard given.

(7) The maximum concentration level varies depending upon the air temperature range in the community of interest.

(8) Samples were filtered through an 0.45 µm membrane filter.

TABLE 3

RESULTS OF ORGANIC U.S. EPA PRIORITY POLLUTANT WATER QUALITY DETERMINATIONS[1]

PARAMETER[2]	UNITS	IMPOUNDED SURFACE WATER			SHALLOW AQUIFER SAMPLING STATIONS				LOWER AQUIFER SAMPLING STATIONS			
		POND 1A	POND 1B	POND 3	P-2S	P-5S	P-6S	P-9S	P-2	P-5	P-6	P-9
Volatile Organic Compounds:												
Chloromethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl chloride	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	µg/ℓ	<10	390	100	36	260	<10	<10	11	625	423	<10
Trichlorofluoromethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	12	<10	<10
1,1-Dichloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	24	<10	<10
trans-1,2-Dichloroethene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroform	µg/ℓ	<10	<10	19	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloroethane	µg/ℓ	<10	<11	<11	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	76	<10	<10
Carbon tetrachloride	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	143	<10	<10
Bromodichloromethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichloropropane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
trans-1,3-Dichloropropene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichloroethene	µg/ℓ	27	25	34	<10	<10	<10	<10	<10	<10	<10	<10
Dibromochloromethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
cis-1,3-Dichloropropene	µg/ℓ	<14	<14	<14	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2-Trichloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene	µg/ℓ	110	<10	50	72	<10	590	<10	<10	<10	<10	21
2-Chloroethylvinyl ether	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,2,2-Tetrachloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Toluene	µg/ℓ	11	<10	43	<10	<10	750	<10	<10	<10	<10	<10
Chlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Ethylbenzene	µg/ℓ	<10	<10	<10	<10	<10	370	<10	<10	<10	<10	<10
Acrolein	µg/ℓ	<200	<200	<200	<100	<100	<100	<100	<100	<100	<100	<100
Acrylonitrile	µg/ℓ	<200	<200	<200	<100	<100	<100	<100	<100	<100	<100	<100
Bis(chloromethyl)ether[3]	µg/ℓ	-[4]	-	-	-	-	-	-	-	-	-	-
Acid Extractables:												
2-Chlorophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
2-Nitrophenol	µg/ℓ	<25	<25	<25	<25	34	<25	<25	<25	<25	<25	<25
Phenol	µg/ℓ	<25	<25	2,200	<25	<25	180,000	<25	<25	<25	<25	<25
2,4-Dimethylphenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
2,4-Dichlorophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
2,4,6-Trichlorophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
4-Chloro-3-methylphenol	µg/ℓ	<25	<25	<25	<25	<25	44,000	<25	<25	<25	<25	<25
2,4-Dinitrophenol	µg/ℓ	<25	<25	<25	87	<25	<25	260	<25	<25	<25	<25
2-Methyl-4,6-dinitrophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Pentachlorophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
4-Nitrophenol	µg/ℓ	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Base Neutral Extractables:												
1,3-Dichlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachloroethane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-chloroethyl)ether	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Dichlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-chloroisopropyl)ether	µg/ℓ	<10	<10	<25	<10	<10	<40	<10	<10	<10	<10	<10
N-Nitrosodipropylamine	µg/ℓ	<12	<12	<30	<10	<10	<60	<10	<10	<10	<10	<10
Isophorone	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrobenzene	µg/ℓ	<10	<10	<25	<10	<10	<40	<10	<10	<10	<10	<10

See footnotes at end of table.

TABLE 3
(Continued)

PARAMETER[2]	UNITS	IMPOUNDED SURFACE WATER			SHALLOW AQUIFER SAMPLING STATIONS				LOWER AQUIFER SAMPLING STATIONS			
		POND 1A	POND 1B	POND 3[5]	P-2S	P-5S	P-6S[6]	P-9S	P-2	P-5	P-6	P-9
Base Neutral Extractables Continued:												
Hexachlorobutadiene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2,4-Trichlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	µg/ℓ	<10	<10	<10	44	<10	<10	<10	<10	<10	<10	<10
Bis(2-chloroethoxy)methane	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hexachlorocyclopentadiene	µg/ℓ	<18	<18	<50	<10	<10	<90	<10	<10	<10	<10	<10
2-Chloronaphthalene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthylene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Acenaphthene	µg/ℓ	<10	<10	90	10	<10	340	<10	<10	<10	<10	<10
Dimethylphthalate	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,6-Dinitrotoluene	µg/ℓ	<10	<10	<10	<10	<10	<30	<10	<10	<10	<10	<10
Fluorene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Chlorophenyl phenyl ether	µg/ℓ	<16	<16	<50	<10	<10	<80	<10	<10	<10	<10	<10
2,4-Dinitrotoluene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,2-Diphenylhydrazine[7]	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	µg/ℓ	110	84	550	<10	<10	<10	<10	<10	<10	<10	<10
N-Nitrosodiphenylamine[8]	µg/ℓ	<10	<10	<10	<10	18	100	<10	<10	<10	<10	<10
Hexachlorobenzene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Bromophenyl phenyl ether	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Phenanthrene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Anthracene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibutylphthalate	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10
Fluoranthene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzidine	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	µg/ℓ	123	182	340	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-ethylhexyl) phthalate	µg/ℓ	<10	88	225	28	100	570	43	36	46	31	30
Chrysene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)anthracene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
3,3'-Dichlorobenzidine	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dioctylphathalate	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(b)fluoranthene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(k)fluoranthene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(a)pyrene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Indeno(1,2,3-c,d)pyrene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dibenzo(a,h)anthracene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzo(g,h,i)perylene	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
N-Nitrosodimethylamine	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,3,7,8-Tetrachlorodibenzo-p-dioxin	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pesticides and Herbicides:												
α-BHC	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
γ-BHC (Lindane)	µg/ℓ	1.7	<1.0	-	<1.0	<1.0	<100	<1.0	<1.0	<1.0	<1.0	<1.0
β-BHC	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Heptachlor	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
δ-BHC	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Aldrin	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Heptachlor epoxide	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Endosulfan I	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Dieldrin	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10

See footnotes at end of table.

TABLE 3
(Continued)

PARAMETER[2]	UNITS	IMPOUNDED SURFACE WATER			SHALLOW AQUIFER SAMPLING STATIONS				LOWER AQUIFER SAMPLING STATIONS			
		POND 1A	POND 1B	POND 3[5]	P-2S	P-5S	P-6S[6]	P-9S	P-2	P-5	P-6	P-9
Pesticides and Herbicides Continued:												
4,4'-DDE	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Endrin	µg/ℓ	<0.20	1.4	-	<0.20	<0.20	<100	0.20	<0.20	<0.20	<0.20	<0.20
Endosulfan II	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
4,4'-DDD	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
4,4'-DDT	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Endrin aldehyde	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Endosulfan sulfate	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Methoxychlor	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Chlordane	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Toxaphene	µg/ℓ	<10	<10	-	<10	<10	<100	<10	<10	<10	<10	<10
Aroclor 1016	µg/ℓ	<20	<20	-	<20	<20	<250	<10	<20	<20	<20	<20
Aroclor 1221	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
Aroclor 1232	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
Aroclor 1242	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
Aroclor 1248	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
Aroclor 1254	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
Aroclor 1260	µg/ℓ	<20	<20	-	<20	<20	<250	<20	<20	<20	<20	<20
2,4-D	µg/ℓ	60	<10	-	<10	<10	1,700[9]	<10	<10	<10	<10	<10
Silvex	µg/ℓ	<2.0	<2.0	-	<20	5.3	110[9]	<2.0	<2.0	<2.0	<2.0	<2.0

(1) See Figure 1 for sampling station locations.
(2) Analytical determinations were in accordance with the U.S. EPA (1980) and U.S. EPA (1977).
(3) Decomposes rapidly in water.
(4) "-" indicates parameter not determined.
(5) Insufficient sample to perform pesticide and herbicide analyses.
(6) Extremely high sulfur content interfering with pesticide and herbicide analyses. Results of gas chromatography/mass spectroscopy analysis and National Bureau of Standards Spectra Library search confirms the presence of organosulfur compounds.
(7) Determined as azobenzene.
(8) Determined as diphenylamine.
(9) Herbicide results may be subject to interferences from high sulfur content in the sample.

TABLE 4

RESULTS OF THE U.S. EPA EXTRACTION PROCEDURE TOXICITY TEST LEACHATE QUALITY DETERMINATIONS FOR IMPOUNDED SLUDGES[1]

PARAMETER[2]	UNITS	U.S. EPA EP TOXICITY TEST LEACHATE QUALITY[3]			U.S. EPA HAZARDOUS WASTE EP TOXICITY STANDARDS[4]
		IMPOUNDMENT NO. 1 SLUDGE	IMPOUNDMENT NO. 2 SLUDGE	IMPOUNDMENT NO. 3 SLUDGE	MAXIMUM LEVEL
pH	pH units	5.15	4.95	5.20	-[5]
Dissolved Solids	mg/ℓ	3,240	1,370	18	-
Chloride	mg/ℓ	8.7	6.3	5.3	-
Fluoride	mg/ℓ	0.32	0.32	0.06	-
Nitrate	mg/ℓ N	0.4	0.1	0.1	-
Sulfate	mg/ℓ	4	<1	<1	-
Oil and Grease	mg/ℓ	12	470	480	-
Total Organic Carbon	mg/ℓ	2,670	1,490	1,520	-
Cyanide	mg/ℓ	0.14	0.07	0.08	-
Metals:					
Aluminum	mg/ℓ	2.0	0.7	0.2	-
Antimony	mg/ℓ	<0.1	<0.1	<0.1	-
Arsenic	mg/ℓ	0.005	0.006	<0.001	5.0
Barium	mg/ℓ	1.6	0.76	0.06	100.0
Beryllium	mg/ℓ	<0.1	<0.1	<0.1	-
Cadmium	mg/ℓ	<0.001	<0.001	<0.001	1.0
Calcium	mg/ℓ	260	220	<1	-
Chromium	mg/ℓ	0.010	0.002	<0.001	5.0
Copper	mg/ℓ	<0.01	<0.01	<0.01	-
Iron	mg/ℓ	44	6.7	0.3	-
Lead	mg/ℓ	0.15	0.02	0.31	5.0
Magnesium	mg/ℓ	50	38	<1	-
Manganese	mg/ℓ	3.8	4.4	<0.1	-
Mercury	mg/ℓ	<0.0005	<0.0005	<0.0005	0.2
Nickel	mg/ℓ	0.1	0.2	<0.1	-
Potassium	mg/ℓ	0.9	2.5	0.2	-
Selenium	mg/ℓ	<0.001	<0.001	<0.001	1.0
Silicon	mg/ℓ	8.1	2.7	0.3	-
Silver	mg/ℓ	<0.001	<0.001	<0.001	5.0
Sodium	mg/ℓ	9.4	1.7	<1.0	-
Thallium	mg/ℓ	14	6	<1	-
Tin	mg/ℓ	<1	<1	<1	-
Vanadium	mg/ℓ	<0.1	<0.1	<0.1	-
Zinc	mg/ℓ	0.73	0.25	0.31	-
Organics:					
Endrin	mg/ℓ	<0.001	<0.001	<0.001	0.02
Lindane	mg/ℓ	<0.010	<0.010	<0.010	0.4
Methoxychlor	mg/ℓ	<0.010	<0.010	<0.010	10.0
Toxaphene	mg/ℓ	<0.010	<0.010	<0.010	0.5
2,4-D	mg/ℓ	<0.010	0.021	<0.010	10.0
2,4,5-TP Silvex	mg/ℓ	<0.002	<0.002	<0.002	1.0

(1) See Figure 1 for sampling station locations.

(2) Analytical determinations were in accordance with the U.S. EPA (1979), APHA (1976), or U.S. EPA (1980).

(3) Leachate quality generated by the U.S. EPA (1980) Extraction Procedure (EP) toxicity test. The procedure involved mixing the sludge samples at a ratio of 1:20 (total) with distilled water, adjustment of the mixture pH to pH 5.0 with acetic acid (if the mixture pH was initially above pH 5.0), and agitation of the mixture for 24 hours, with the pH monitored and adjusted for the first six hours of agitation. At the end of the 24-hour agitation, the leachate was filtered and the filtrate analyzed.

(4) U.S. EPA, 1980, Federal Register, Vol. 45, No. 98, Part III, pp. 33083-33133.

(5) "-" indicates no standard given.

TABLE 5

RESULTS OF ORGANIC U.S. EPA PRIORITY POLLUTANT DETERMINATIONS FOR IMPOUNDED SLUDGES

PARAMETER(1)	UNITS	SAMPLING STATION(2)		
		IMPOUNDMENT NO. 1 SLUDGE	IMPOUNDMENT NO. 2 SLUDGE	IMPOUNDMENT NO. 3 SLUDGE
Volatile Organic Compounds:				
Chloromethane	mg/kg	<0.1	<0.1	<0.1
Bromomethane	mg/kg	<0.1	<0.1	<0.1
Vinyl chloride	mg/kg	<0.1	<0.1	<0.1
Chloroethane	mg/kg	<0.1	<0.1	<0.1
Methylene chloride	mg/kg	<0.1	<0.1	<0.1
Trichlorofluoromethane	mg/kg	<0.1	<0.1	<0.1
1,1-Dichloroethene	mg/kg	<0.1	<0.1	<0.1
1,1-Dichloroethane	mg/kg	<0.1	<0.1	<0.1
trans-1,2-Dichloroethene	mg/kg	<0.1	<0.1	<0.1
Chloroform	mg/kg	<0.1	<0.1	<0.1
1,2-Dichloroethane	mg/kg	<0.1	<0.1	<0.1
1,1,1-Trichloroethane	mg/kg	<0.1	<0.1	0.2
Carbon tetrachloride	mg/kg	<0.1	<0.1	<0.1
Bromodichloromethane	mg/kg	<0.1	<0.1	<0.1
1,2-Dichloropropane	mg/kg	<0.1	<0.1	<0.1
trans-1,3-Dichloropropene	mg/kg	<0.1	<0.1	<0.1
Trichloroethene	mg/kg	<0.1	<0.1	0.2
Dibromochloromethane	mg/kg	<0.1	<0.1	<0.1
cis-1,3-Dichloropropene	mg/kg	<0.1	<0.1	<0.1
1,1,2-Trichloroethane	mg/kg	<0.1	<0.1	<0.1
Benzene	mg/kg	2.5	<0.1	5.1
2-Chloroethylvinyl ether	mg/kg	<0.1	<0.1	<0.1
Bromoform	mg/kg	<0.1	<0.1	<0.1
Tetrachloroethene	mg/kg	<0.1	<0.1	<0.1
1,1,2,2-Tetrachloroethane	mg/kg	<0.1	<0.1	<0.1
Toluene	mg/kg	0.6	<0.1	1.1
Chlorobenzene	mg/kg	<0.1	<0.10	<0.1
Ethylbenzene	mg/kg	0.3	<0.1	0.2
Acrolein	mg/kg	<1.0	<1.0	<1.0
Acrylonitrile	mg/kg	<1.0	<1.0	<1.0
Bis(chloromethyl)ether(3)	mg/kg	-(4)	-	-
Acid Extractables:				
2-Chlorophenol	mg/kg	<10	<1.0	<10
2-Nitrophenol	mg/kg	<10	<1.0	<10
Phenol	mg/kg	<10	<1.0	<10
2,4-Dimethylphenol	mg/kg	<10	<1.0	<10
2,4-Dichlorophenol	mg/kg	<10	<1.0	<10
2,4,6-Trichlorophenol	mg/kg	<10	<1.0	<10
4-Chloro-3-methylphenol	mg/kg	<10	<1.0	<10
2,4-Dinitrophenol	mg/kg	<10	<1.0	<10
2-Methyl-4,6-dinitrophenol	mg/kg	<10	<1.0	<10
Pentachlorophenol	mg/kg	<10	<1.0	<10
4-Nitrophenol	mg/kg	<10	<1.0	<10
Base Neutral Extractables:				
1,3-Dichlorobenzene	mg/kg	<10	<1.0	<10
1,4-Dichlorobenzene	mg/kg	<10	<1.0	<10
Hexachloroethane	mg/kg	<10	<1.0	<10
Bis(2-chloroethyl)ether	mg/kg	<10	<1.0	<10
1,2-Dichlorobenzene	mg/kg	<10	<1.0	<10

See footnotes at end of table.

TABLE 5
(Continued)

PARAMETER(1)	UNITS	SAMPLING STATION(2)		
		IMPOUNDMENT NO. 1 SLUDGE	IMPOUNDMENT NO. 2 SLUDGE	IMPOUNDMENT NO. 3 SLUDGE
Base Neutral Extractables Continued:				
Bis(2-chloroisopropyl)ether	mg/kg	<10	<1.0	<10
N-Nitrosodipropylamine	mg/kg	<10	<1.0	<10
Isophorone	mg/kg	<10	<1.0	<10
Nitrobenzene	mg/kg	<10	<1.0	<10
Hexachlorobutadiene	mg/kg	<10	<1.0	<10
1,2,4-Trichlorobenzene	mg/kg	<10	<1.0	<10
Naphthalene	mg/kg	<10	<1.0	<10
Bis(2-chloroethoxy)methane	mg/kg	<10	39	<10
Hexachlorocyclopentadiene	mg/kg	<10	<1.0	<10
2-Chloronaphthalene	mg/kg	<10	<1.0	<10
Acenaphthylene	mg/kg	<10	<1.0	<10
Acenaphthene	mg/kg	<10	1.0	<10
Dimethylphthalate	mg/kg	<10	<1.0	<10
2,6-Dinitrotoluene	mg/kg	<10	<1.0	<10
Fluorene	mg/kg	<10	<1.0	<10
4-Chlorophenyl phenyl ether	mg/kg	<10	<1.0	<10
2,4-Dinitrotoluene	mg/kg	<10	<1.0	<10
1,2-Diphenylhydrazine(5)	mg/kg	<10	<1.0	<10
Diethylphthalate	mg/kg	440	16	960
N-Nitrosodiphenylamine(6)	mg/kg	<10	<1.0	<10
Hexachlorobenzene	mg/kg	<10	<1.0	<10
4-Bromophenyl phenyl ether	mg/kg	<10	<1.0	<10
Phenanthrene	mg/kg	<10	<1.0	<10
Anthracene	mg/kg	<10	<1.0	<10
Dibutylphthalate	mg/kg	<10	<1.0	<10
Fluoranthene	mg/kg	<10	<1.0	<10
Pyrene	mg/kg	<10	<1.0	<10
Benzidine	mg/kg	<10	<1.0	<10
Butylbenzylphathalate	mg/kg	410	<1.0	540
Bis(2-ethylhexyl) phthalate	mg/kg	<10	19	<10
Chrysene	mg/kg	<10	<1.0	<10
Benzoa(a)anthracene	mg/kg	<10	<1.0	<10
3,3'-Dichlorobenzidine	mg/kg	<10	<1.0	<10
Dioctylphathalate	mg/kg	<10	<1.0	<10
Benzo(b)fluoranthene	mg/kg	<10	<1.0	<10
Benzo(k)fluoranthene	mg/kg	<10	<1.0	<10
Benzo(a)pyrene	mg/kg	<10	<1.0	<10
Indeno(1,2,3-c,d)pyrene	mg/kg	<10	<1.0	<10
Dibenzo(a,h)anthracene	mg/kg	<10	<1.0	<10
Benzo(g,h,i)perylene	mg/kg	<10	<1.0	<10
N-Nitrosodimethylamine	mg/kg	<10	<1.0	<10
2,3,7,8-Tetrachlorodibenzo-p-dioxin	mg/kg	<10	<1.0	<10
Pesticides and Herbicides:				
α-BHC	mg/kg	<1.0	<1.0	<1.0
γ-BHC (Lindane)	mg/kg	<1.0	<1.0	<1.0
β-BHC	mg/kg	<1.0	<1.0	<1.0
Heptachlor	mg/kg	<1.0	<1.0	<1.0
δ-BHC	mg/kg	<1.0	<1.0	<1.0
Aldrin	mg/kg	<1.0	<1.0	<1.0
Heptachlor epoxide	mg/kg	<1.0	<1.0	<1.0

See footnotes at end of table.

TABLE 5
(Continued)

PARAMETER[1]	UNITS	SAMPLING STATION[2]		
		IMPOUNDMENT NO. 1 SLUDGE	IMPOUNDMENT NO. 2 SLUDGE	IMPOUNDMENT NO. 3 SLUDGE
Pesticides and Herbicides Continued:				
Endosulfan I	mg/kg	<1.0	<1.0	<1.0
Dieldrin	mg/kg	<1.0	<1.0	<1.0
4,4'-DDE	mg/kg	<1.0	<1.0	<1.0
Endrin	mg/kg	<1.0	<1.0	<1.0
Endosulfan II	mg/kg	<1.0	<0.1	<1.0
4,4'-DDD	mg/kg	<1.0	<1.0	<1.0
4,4'-DDT	mg/kg	<1.0	<1.0	<1.0
Endrin aldehyde	mg/kg	<1.0	<1.0	<1.0
Endosulfan sulfate	mg/kg	<1.0	<1.0	<1.0
Methoxychlor	mg/kg	<1.0	<1.0	<1.0
Chlordane	mg/kg	<1.0	<1.0	<1.0
Toxaphene	mg/kg	<1.0	<1.0	<1.0
Aroclor 1016	mg/kg	<10	<10	<10
Aroclor 1221	mg/kg	<10	<10	<10
Aroclor 1232	mg/kg	<10	<10	<10
Aroclor 1242	mg/kg	<10	<10	<10
Aroclor 1248	mg/kg	<10	<10	<10
Aroclor 1254	mg/kg	<10	<10	<10
Aroclor 1260	mg/kg	<10	<10	<10
2,4-D	mg/kg	1.3	<0.10	0.45
Silvex	mg/kg	<0.10	<0.10	<0.10

(1)Extraction and analytical procedures were in accordance with the U.S EPA (1980).
(2)See Figure 1 for sampling station locations.
(3)Decomposes rapidly in water.
(4)"-" indicates parameter not determined.
(5)Determined as azobenzene.
(6)Determined as diphenylamine.

TABLE 6

RESULTS OF SLUDGE BIODEGRADATION/GAS GENERATION CHARACTERIZATION(1)

SAMPLE MIXTURE(2)	MAXIMUM GAS PRESSURE GENERATED (mm Hg)	TIME TO MAXIMUM GAS PRESSURE (hours)	GAS PRESSURE AT 24±2 HOURS (mm Hg)	FINAL GAS PRESSURE (mm Hg)	TIME TO FINAL GAS PRESSURE (hours)	VOLUME OF GAS PRODUCED/CONSUMED		MAXIMUM VOLUME OF GAS PRODUCED(3) (cu. ft./short ton sludge)
						MAXIMUM POSITIVE PRESSURE (cc)	MAXIMUM NEGATIVE PRESSURE (cc)	
50:50 Impoundment No. 1 Sludge:Sewage	29±1	1	18	4	72	0.34	-(4)	0.11
50:50 Impoundment No. 2 Sludge:Sewage	30±1	0.5	16	-16	69.5	0.36	0.21	0.12
50:50 Impoundment No. 3 Sludge:Sewage	28±1	1	19	5	72	0.33	-	0.11
10:90 Impoundment No. 3 Sludge:Sewage	32±1	2.5	21	12	72	0.38	-	0.61
50:50 Impoundment No. 1 Sludge:Soil(5)	16±1	0.5	-2	-38	69.5	0.19	0.47	0.06
50:50 Impoundment No. 3 Sludge:Soil(6)	15±1	1	3	-10	69.5	0.18	0.07	0.06
100 Percent Impoundment No. 1 Sludge	9	14	-12	-18	42	0.14	0.26	0.04
100 Percent Sewage	35±1	3	16	-22	72	0.41	0.28	0.07(7)
100 Percent Distilled Water	26	7	16	16	46	0.31	-	NA(8)

(1) See text for discussion of methodology. Temperature remained constant at 35°C.

(2) See Figure 1 for sample station locations. Sewage used was an industrial sewage obtained from the Allegheny County Sanitary Authority plant in McKeesport, Pennsylvania. Sample mixtures had a mass of 200 grams, except the 100 percent impoundment No. 1 sludge sample which had a mass of 100 grams.

(3) Calculation assumes gas generated only from sludge. Therefore, the reported values are unrealistically high as the sewage was shown to generate gas.

(4) "-" *indicates no negative pressure occurred or more gas was produced than consumed.*

(5) Soil from Boring B-17, 11.5 to 13.0 feet.

(6) Soil from Boring B-14, 4.0 to 8.0 feet.

(7) Units are cubic feet of gas per short ton of sewage.

(8) NA = Not applicable.

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TABLE 7
FIELD CONDUCTIVITY TEST, PIEZOMETERS 1 THROUGH 16
DECEMBER 30 AND 31, 1980

PIEZOMETER NO.	TEMPERATURE OF PIEZOMETER WATER AND POLLUTANTS	DEPTH BELOW TOP OF PIEZOMETER	CONDUCTIVITY IN 1000 µmhos/cm
P1S	16°C	33'0"	4.0
		32'0"	4.6
		30'0"	6.5
		26'0"	6.0
		22'6"	5.0
		21'8"	4.7
	17°C	20'4"	4.0
		19'6"	0
P1	13°C	56'8"	.7
	15°C	45'0"	.68
		40'0"	0
P2S	15°C	38'5"	1.4
		37'5"	1.5
		36'3"	1.6
	16°C	35'0"	1.7
		24'10"	0
P2	15°C	75'0"	.65
		73'0"	.7
		61'5"	.65
	14°C	59'0"	.6
		48'5"	0
P3	13°C	63'3"	.75
		61'0"	.9
		59'0"	.8
		58'0"	.7
	15°C	45'0"	.65
		39'1"	0
P4	12°C	50'6"	1.3
		49'4"	1.5
		48'10"	1.9
	14.5°C	48'0"	2.2
		33'10"	0
P5S	14.5°C	29'10"	1.2
		28'10"	0

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TABLE 7
FIELD CONDUCTIVITY TEST, PIEZOMETERS 1 THROUGH 16

(continued)

PIEZOMETER NO.	TEMPERATURE OF PIEZOMETER WATER AND POLLUTANTS	DEPTH BELOW TOP OF PIEZOMETER	CONDUCTIVITY IN 1000 µmhos/cm
P5	14.0°C	61'8"	2
		59'8"	2.2
		50'10"	2.1
		50'0"	1.9
		49'2"	1.8
		47'7"	1.7
		46'10"	1.5
		46'2"	1.3
		45'6"	1.2
	15.0°C	44'2"	1.1
		42'8"	0
P6S	16°C	24'4"	11
		23'11"	18
		23'0"	22
		21'4"	25
	12°C	15'4"	25
		15'2"	0
P6	16°C	44'7"	.85
		42'10"	1.15
		35'4"	1.0
	15°C	34'10"	.9
		34'7"	0
P7	12°C	51'2"	1.5
		48'11"	2.0
	13°C	42'2"	2.0
		41'10"	0
P8	14°C	60'10"	.35
		59'2"	.45
		44'2"	.4
	14°C	41'10"	.35
		41'5"	0
P9S	14°C	19'4"	1.0
		18'0"	1.5
	9°C	2'8"	1.5
		2'3"	0

TABLE 7
FIELD CONDUCTIVITY TEST, PIEZOMETERS 1 THROUGH 16

(continued)

PIEZOMETER NO.	TEMPERATURE OF PIEZOMETER WATER AND POLLUTANTS	DEPTH BELOW TOP OF PIEZOMETER	CONDUCTIVITY IN 1000 μmhos/cm
P9	13°C	47'0"	.5
	14°C	28'0"	.5
		27'7"	0
P10	15°C	51'10"	1.0
		49'3"	1.5
	15°C	48'9"	1.5
		48'6"	0
P10A	15°C	49'8"	1.5
	15°C	44'5"	1.5
		43'10"	0
P11	16°C	30'9"	1.0
	17°C	28'0"	1.5
		27'8"	0
P12S	15°C	19'4"	11
		19'0"	20
		6'7"	17
		5'7"	15
		5'0"	12
		4'7"	8.5
		3'8"	6.0
		3'0"	5.0
	14°C	2'3"	5.0
		2'0"	0
P12	13°C	48'1"	.35
		47'2"	.6
		37'6"	.5
	14.5°C	29'8"	.45
		28'11"	0
P13	13°C	59'8"	1.0
		56'9"	1.1
	14°C	44'4"	1.1
		43'10"	0

TABLE 7
FIELD CONDUCTIVITY TEST, PIEZOMETERS 1 THROUGH 16

(continued)

PIEZOMETER NO.	TEMPERATURE OF PIEZOMETER WATER AND POLLUTANTS	DEPTH BELOW TOP OF PIEZOMETER	CONDUCTIVITY IN 1000 µmhos/cm
P14S	16°C	19'2"	2.0
		18'4"	2.5
		17'5"	3.0
	16°C	12'0"	2.5
		11'6"	0
P15S	15°C	22'11"	2.2
		22'1"	3.3
		21'11"	3.7
		21'8"	4.0
		21'6"	4.5
		20'1"	4.8
		19'2"	5.0
	17°C	12'3"	5.0
		11'3"	0
P15	13.5°C	38'0"	1.0
		36'11"	1.25
	14°C	36'4"	1.4
		31'8"	0
P16S	15°C	36'4"	7.0
		34'9"	10
		32'8"	11
		29'5"	10
		28'0"	8.5
		22'11"	7.5
	17°C	20'0"	7.0
		19'10"	0
P16	14°C	56'6"	4.2
		54'5"	6.0
		53'9"	8.0
	15°C	43'11"	8.0
		43'9"	0

NOTES: 1. For piezometer locations See Figure 1. Piezometer Nos. P10, P10A and P11 are outside of impoundment areas.

2. Conductivities are graphically presented on Figures 6A and 7A.

TABLE 8
BENTONITE FILTER CAKE TEST NO. 1
(BENTONITE SB125)

Date	Time	Elapsed Time (Min.)	Cake Sample #1 & Distilled Water	Cake Sample #2 & Distilled Water			Cake Sample #3 & P6S Polluted Water.			Leachate Ratio $\frac{Qp}{Q_{DW}}$
			ml	ml	pH	Sp. Con.	ml	pH	Sp. Con.	
1/5/81	10:20	Form the cake in 2 hours using distilled water.	0	0			0			
	12:20		23.5	25.0			24.0			
		Cake thickness	initial 0.14"	final 0.132"			final 0.115"			
	13:00	0		0			0			
	13:45	45	-	5.0			4.5			0.90
	14:00	60	-	6.4	9.01	850	5.7	8.2	4,500	0.89
	14:00	0		0			0			
	15:00	60	-	5.8	9.36	410	5.0	9.6	14,000	0.86
	15:00	0		0			0			
	16:00	60	-	5.0	9.38	400	4.1	9.95	21,000	0.82
	16:00	0		0			0			
	17:00	60	-	5.2	9.36	290	3.9	10.21	27,000	0.75
	17:00	0		0			0			
1/6/81	08:30	930	-	65.0	9.21	120	41.5	10.46	21,000	0.64
	08:30	0		0			0			
	11:00	150	-	11.6	9.12	90	5.1	10.50	26,500	0.44
	11:00	0		0			0			
	13:00	120	-	10.8	9.14	80	5.0	10.54	27,000	0.46
	13:00	0		0			0			
	15:00	120	-	10.8	8.98	240	4.9	10.62	39,000	0.45
	15:00	0		0			0			
	17:00	120	-	10.6	8.98	70	4.5	10.53	29,000	0.42
	17:00	0		0			0			
1/7/81	08:00	900	-	67.0	8.82	80	26.0	10.71	12,000	0.39
	08:00	0		0			0			
	15:30	450	-	19.5	8.54	70	5.4	10.76	24,000	0.28
	15:30	0		0			0			
	18:00	150	-	12.0	8.35	70	5.6	10.79	-	0.47
	18:00	0		0			0			
1/8/81	08:30	870	-	48.0	8.25	70	14	10.94	23,000	0.29
	08:30	0		0			0			
	11:00	150	-	10.0	7.93	80	2.3	-	30,000	0.23

For Legend See Table 10

TABLE 9
BENTONITE FILTER CAKE TEST NO. 2
(IMC BENTONITE)

Date	Time	Elapsed Time (Min.)	Cake Sample #4 & Distilled Water	Cake Sample #5 & Distilled Water			Cake Sample #6 & P6S Polluted Water.			Leachate Ratio $\frac{Q_p}{Q_{DW}}$
			ml	ml	pH	Sp. Con.	ml	pH	Sp. Con.	
1/9/81	08:10	Form the cake in 2 hours using distilled water.	0	0			0			
	10:10		20.0	19.4	7.36	1,300	20.2	8.36	1,400	-
		Cake thickness	initial 0.131"	final 0.160"			final 0.152"			
	10:30	0								
	11:30	60	-	4.4	7.77	1,250	4.8	9.27	35,000	1.09
	11:30	0								
	13:30	120	-	8.6	7.85	630	7.4	9.47	15,000	0.86
	13:30	0								
	16:45	195	-	12.6	8.39	310	8.8	10.21	19,000	0.70
	16:45	0								
1/10/81	09:30	1,005	-	59.5	7.38	175	40.0	10.39	10,000	0.67
	09:30	0								
	13:00	210	-	13.5	8.65	150	8.4	10.58	28,000	0.62
	13:00	0								
1/11/81	12:00	1,380	-	83.0	8.68	100	43.0	10.75	26,000	0.52
	12:00	0								
1/12/81	08:30	1,230	-	73.0	8.40	100	30.0	10.70	30,000	0.41
	08:30	0								
1/13/81	08:30	1,440	-	79.0	7.70	130	26.5	10.76	29,000	0.34

For Legend See Table 10

TABLE 10
BENTONITE FILTER CAKE TEST NO. 3
(IMC BENTONITE)

Date	Time	Elapsed Time (Min.)	Cake Sample #7 & Distilled Water			Cake Sample #8 & P6S Polluted Water			Leachate Ratio $\frac{Qp}{Q_{DW}}$
			ml	pH	Sp. Con.	ml	pH	Sp. Con.	
1/14/81	07:45	Form the cake in 2 hours using distilled water.							
	09:45		20.0			20.0			
	10:30	0		8.50	1,500		8.30	1,500	
	14:15	225	16.5	8.30	1,050	15.0	9.70	13,000	0.91
	14:15	0							
	17:15	180	11.5	7.15	400	8.1	10.40	25,000	0.70
	17:15	0							
1/15/81	07:45	870	50.0	7.80	225	32.0	10.70	29,000	0.64
	07:45	0							
	13:30	345	20.0	8.25	175	12.6	10.85	29,000	0.63
	13:30	0							
	18:00	270	15.0	7.90	180	9.0	9.55	40,000 (1)	0.60
	18:00	0							
1/16/81	06:30	750	42.0	7.65	110	22.0	10.31	27,000	0.52
	06:30	0							
	14:15	465	27.0	7.35	130	12.6	10.27	27,000 (2)	0.47
	14:15	0							
1/17/81	10:50	1,235	69.0	7.80	110	23.5	10.20	27,000	0.34
	10:50	0							
1/18/81	14:15	1,645	87.5	7.61	100	19.0	10.07	29,000	0.22
	14:15	0							
1/19/81	14:00	1,425	62.0	7.70	160	12.6	10.32	26,000	0.20

LEGEND: ml = leachate in milliliters
Sp. Con. = leachate specific conductivity, μmhos/cm
Qp = quantity of polluted water flows through bentonite cake
Q_{DW} = quantity of distilled water flows through bentonite cake
(1) 10/0.8 dilution factor
(2) 10/4.4 dilution factor

Average permeability of bentonite filter cake is 2×10^{-9} cm/sec for polluted water (Tables 8, 9 and 10).

TABLE 11

SOIL-BENTONITE BACKFILL SAMPLES PREPARED FOR PERMEABILITY TESTS IN THE TRIAXIAL CELL

Date prepared January 2, and January 5, 1981 by Geoff Shallard and Gene MacEvoy

Sample #1SL

Blended contaminated flyash and sand from spoon samples #2 through #6 of Boring 14 and spoon samples #1 through #6 of Boring 5.

	Dry Wt. gm.	Wet Wt. gm.	Total Wt. gm.
Tare 22A	88.09	-	88.09
B14 Water Content 52.7%	300	458.10	546.19
B5 Water Content 47.1%	300	441.30	987.45

Add 150 cc of slurry which contains 6.34 gm. of bentonite (1% dry wt. of soil)

Final WC = 75%

Sample #2SL

Blended clayey silt from spoon sample #10 of Boring 1, spoon sample #12 of Boring 5, spoon samples #11 and #12 of Boring 14.

	Dry Wt. gm.	Wet Wt. gm.	Total Wt. gm.
Tare 121	89.16	-	89.16
Water Content 29%	461.46	595.29	684.45

Add 150 cc slurry which contains 6.3 gm. of bentonite (1% dry wt. of soil)
Add 20 cc slurry
Final WC = 66%

Sample #3SL

Blended 50% of sample #1SL and 50% of sample #2SL as shown above.

	Dry Wt. gm.	Wet Wt. gm.	Total Wt. gm.
Tare 19	110.50	-	110.50
Clayey Silt, WC = 29.6%(#2SL)	300.00	388.80	499.30
B14(#1SL)	150.00	229.05	728.35
B5 (#1SL)	150.00	220.65	949.00

Add 150 cc slurry which contains 6.3 gm. of bentonite (1% dry wt. of soil)
Final WC = 65%

Sample #4SL

Silt from borrow area (Barton Brown Silt Sample 5)

	Dry Wt. gm.	Wet Wt. gm.	Total Wt. gm.
Tare 92	166.90	-	166.90
Silt, WC = 9.1%	600.00	654.6	821.50

Add 150 cc slurry which contains 6.3 gm. of bentonite (1% dry wt. of soil)
Add 20 cc water.
Final WC = 37%.

TABLE 11
(continued)

Sample #5SL

20% silty clay and 80% sand.
Silty Clay material from spoon sample 5 of Boring 17.
Sand: Penn Grove sand

	Dry Wt. gm.	Wet Wt. gm.	Total Wt. gm.
Tare 1	107.23	-	107.23
Silty Clay 30% WC	120	156	263.23
Sand oven dry	480	480	743.23
Add 150 cc slurry			
Add 50 cc water			
Final WC = 33%			

These five soil-bentonite mixtures were used for the permeability tests in the triaxial cell. Each mixture was troweled in the sample mold, 2.8 inches in diameter and 2.8 inches high for the test. The purpose of mixing 5 samples was:

Sample #1SL: Check permeability of the upper portion in situ soils (contaminated flyash, and sand) mixed with bentonite slurry.

Sample #2SL: Check permeability of the lower portion in situ soils (contaminated silty clay) mixed with bentonite slurry.

Sample #3SL: Check permeability of blended samples 1SL and 2SL mixed with bentonite slurry.

Sample #4SL: Check permeability of silt from borrow area mixed with bentonite slurry.

Sample #5SL: Check permeability of imported sand and in situ silty clay mixed with bentonite slurry.

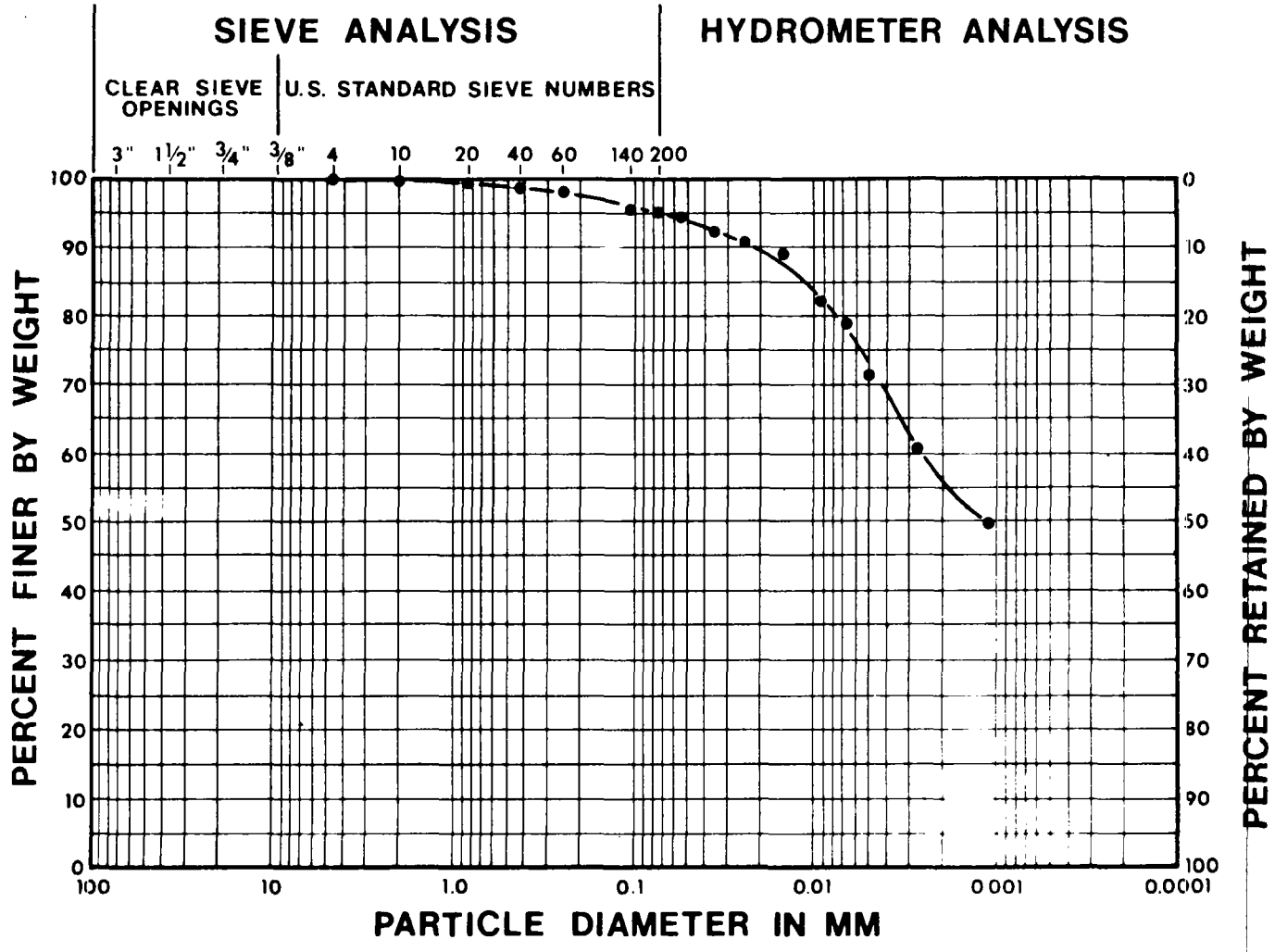
TABLE 12
PERMEABILITY VERSUS MODIFIED PROCTOR DRY DENSITY
FOR BORROW MATERIAL, SAMPLE NO. 4

Test No.	Initial Dry Density, PCF	Initial Water Content %	Percent of Modified Proctor Dry Density of 115.5 PCF	Permeability At 20°C K_{20}, cm/sec
1	93.7	15	81.1	9.9×10^{-8}
2	103.2	15	89.4	4.1×10^{-9}
3	111.4	15	96.5	3.7×10^{-9}

FIGURES

CANONIE
D'APPOLONIA

DRAWN BY	WJ	1-30-81	CHECKED BY	CC	1-30-81	DRAWING NUMBER	MW80-857-A11
			APPROVED BY	RCV	2-1-81		



COBBLES	GRAVEL		SAND			SILT FRACTION	CLAY FRACTION
	coarse	fine	coarse	medium	fine		

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	WC %
	SEE NOTE	1		DARK GRAY CLAY-TRACE OF FINE SAND (visual inspection called black clay)	CH	89.8	28.0	38.3

NOTE

SAMPLE NO. 1 MATERIAL IS FROM ONE 25 LB. CAN SAMPLE FURNISHED BY BARTON COMPANY. TEST DATE 1-26-81.

FIGURE 1A

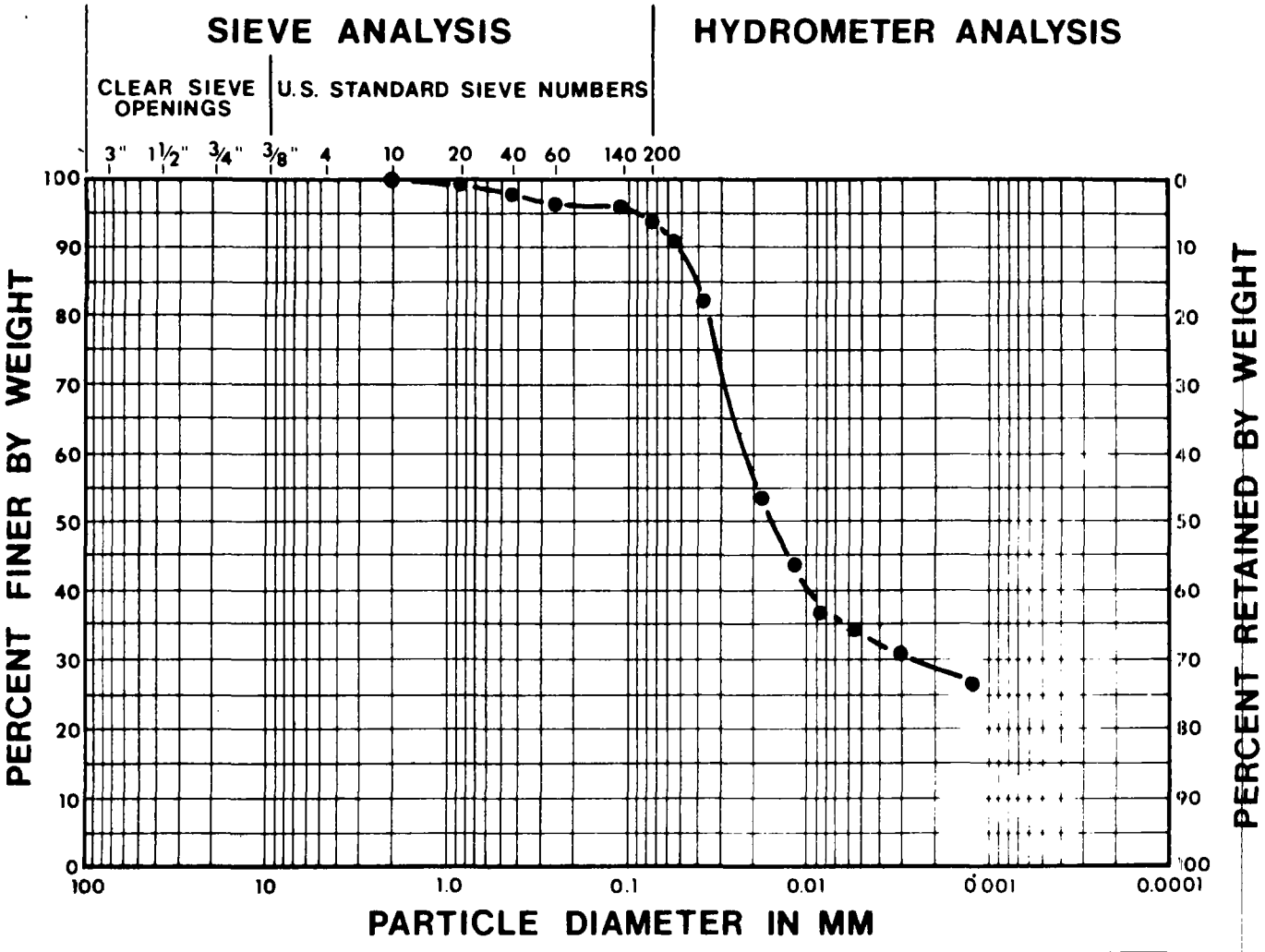
SAMPLE NO. 1
GRAIN SIZE ANALYSIS
BARTON DARK GRAY CLAY
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE D'APPOLONIA

DRAWN BY	MTM	CHECKED BY	CC	1-30-81	DRAWING NUMBER	MW80-857-A7
	1-21-81	APPROVED BY	RCV	2-1-81		



COBBLES	GRAVEL		SAND			SILT FRACTION	CLAY FRACTION
	coarse	fine	coarse	medium	fine		

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	WC%
	SEE NOTE	2		BROWN SILTY CLAY, TRACE OF SAND (visual inspection called brown silt)	CL	47.5	26.4	21.4

NOTE

SAMPLE NO. 2 IS FROM ONE 25 LB. CAN SAMPLE FURNISHED BY BARTON COMPANY. TEST DATE: 1-13-81.

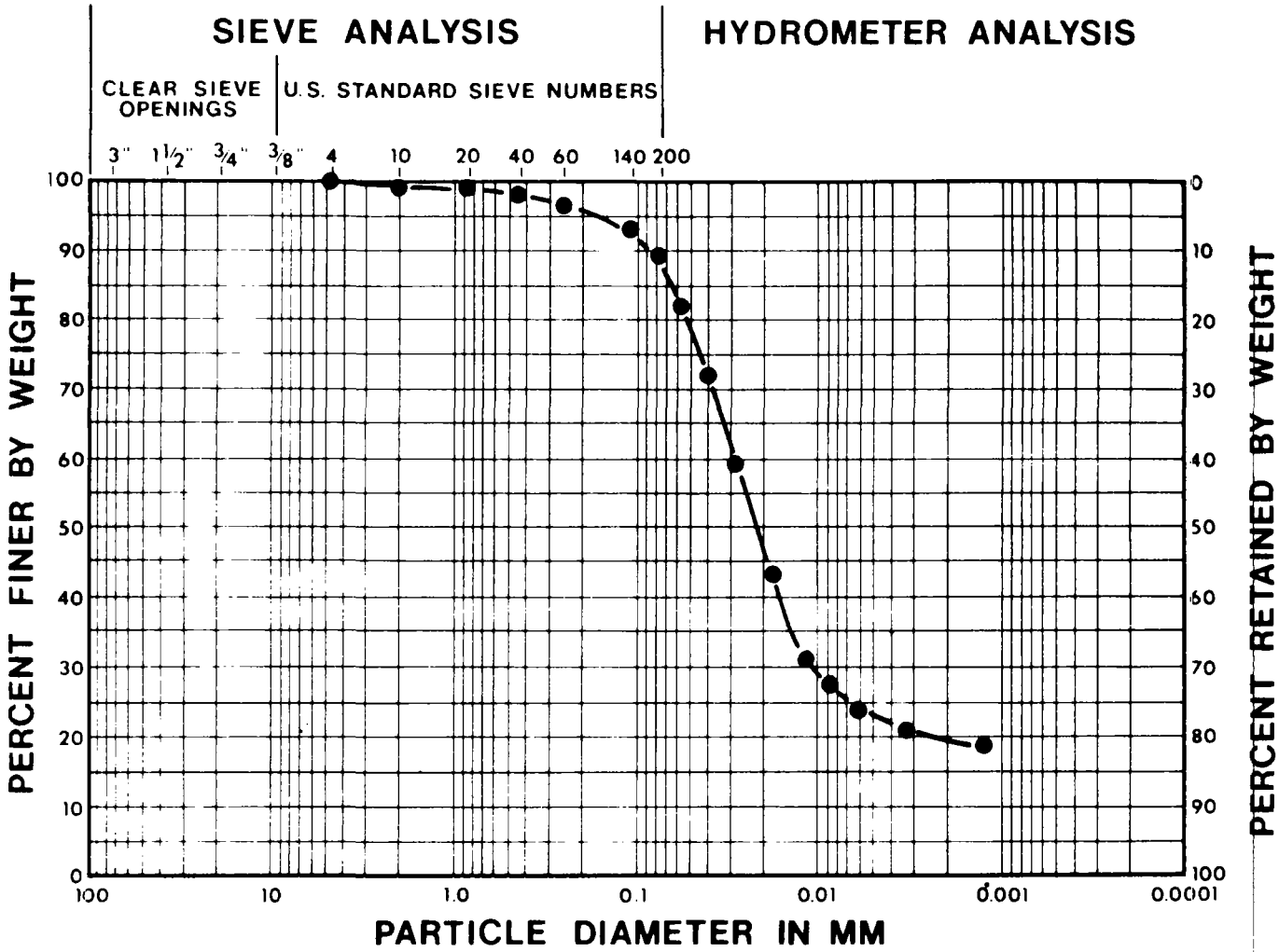
FIGURE 2A
SAMPLE NO. 2
GRAIN SIZE ANALYSIS
BARTON BROWN SILT
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE D'APPOLONIA

DRAWN BY	MTM	CHECKED BY	CC	2-1-81	DRAWING NUMBER MW-80-857-A9
	1-26-81	APPROVED BY	RCV	2-1-81	



COBBLES	GRAVEL		SAND			SILT FRACTION	CLAY FRACTION
	coarse	fine	coarse	medium	fine		

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	WC %
	SEE	3		BROWN SILT	ML	33.9	30.0	20.3
	NOTE			(visual inspection called gray brown silt)				

NOTE

SAMPLE NO. 3 MATERIAL IS FROM ONE 25 LB. BAG SAMPLE FURNISHED BY HELMKAMP COMPANY.
TEST DATE 1-13-81.

FIGURE 3A

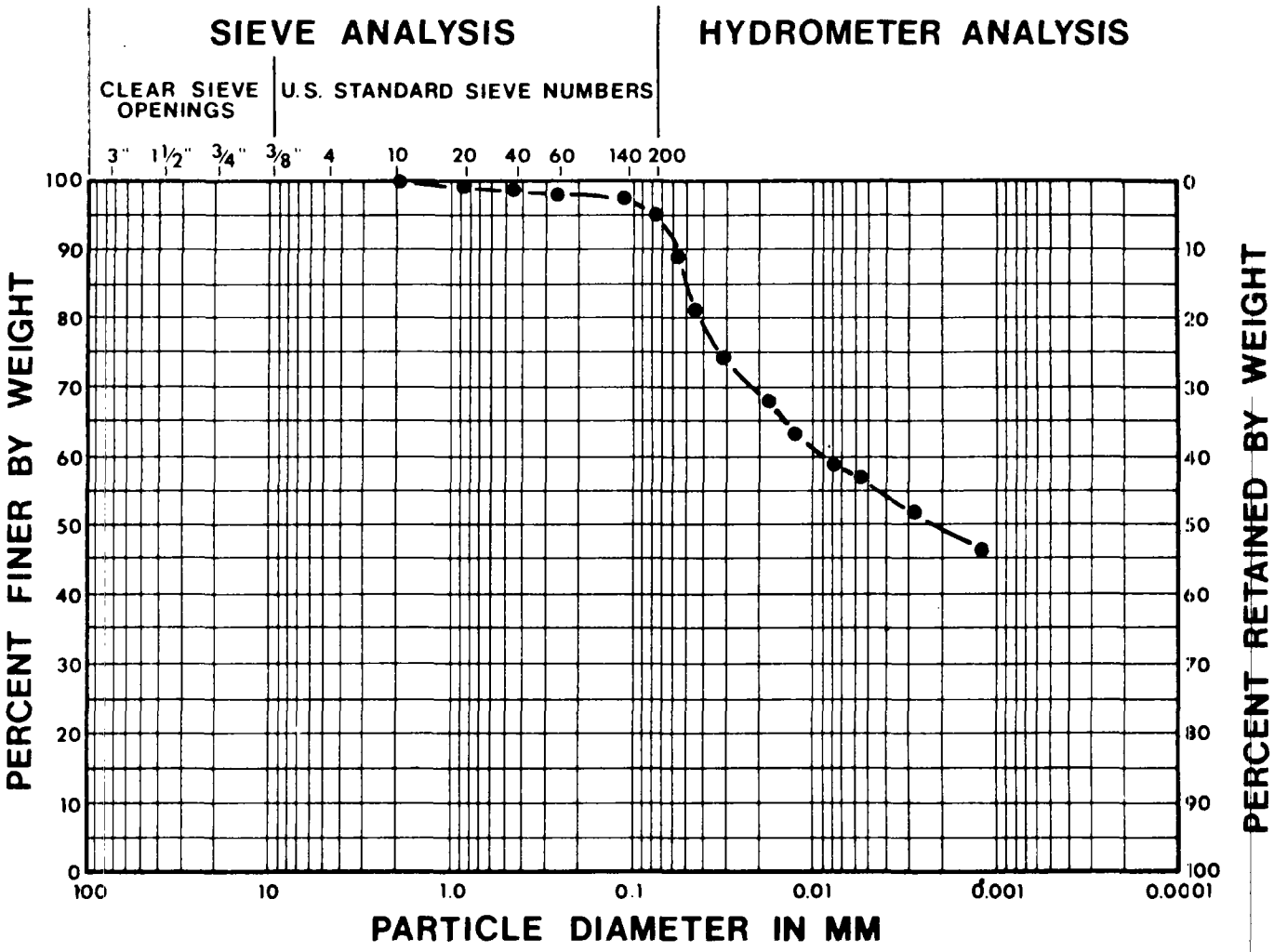
SAMPLE NO. 3
GRAIN SIZE ANALYSIS
HELMKAMP GRAY BROWN SILT
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
D'APPOLONIA

DRAWN BY	MTM	CHECKED BY	CC	1-30-81	DRAWING NUMBER	MW80-857-A8
	1-26-81	APPROVED BY	RCV	2-1-81		



COBBLES	GRAVEL		SAND			SILT FRACTION	CLAY FRACTION
	coarse	fine	coarse	medium	fine		

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	WC %
	SEE	4		DARK GRAY CLAY-TRACE OF FINE SAND	CH	60.9	19.7	12.6
	NOTE			(visual inspection called gray black clay)				

NOTE

SAMPLE NO. 4 MATERIAL IS FROM ONE 25 LB. BAG SAMPLE FURNISHED BY HELMKAMP COMPANY.
TEST DATE 1-10-81.

FIGURE 4A

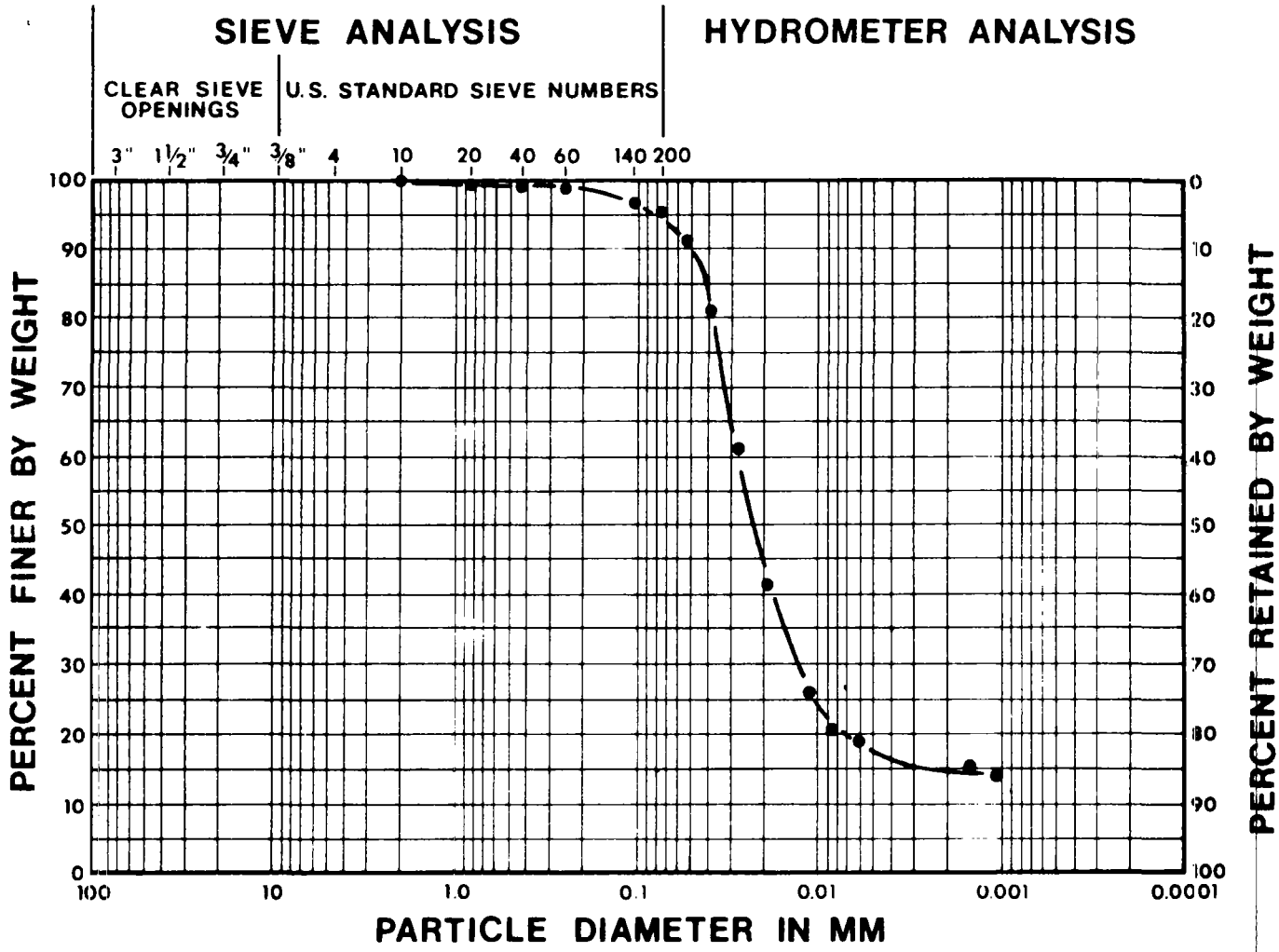
SAMPLE NO. 4
GRAIN SIZE ANALYSIS
HELMKAMP GRAY BLACK CLAY
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
D'APPOLONIA

DRAWN BY	WJ	CHECKED BY	CC	DRAWING NUMBER	MW80-857A13
	1-30-81	APPROVED BY	RCV		
			2-1-81		



COBBLES	GRAVEL		SAND			SILT FRACTION	CLAY FRACTION
	coarse	fine	coarse	medium	fine		

SYMBOL	BORING	SAMPLE	DEPTH	SOIL DESCRIPTION	U.S.C.S.	L.L.	P.L.	WC%
	SEE NOTE	5		BROWN SILT	ML	29.2	26.0	6.1
				(visual inspection called brown silt)				

NOTE

SAMPLE NO. 5 MATERIAL IS FROM ONE 25 LB. CAN SAMPLE FURNISHED BY BARTON COMPANY.
TEST DATE 1-21-81.

FIGURE 5A

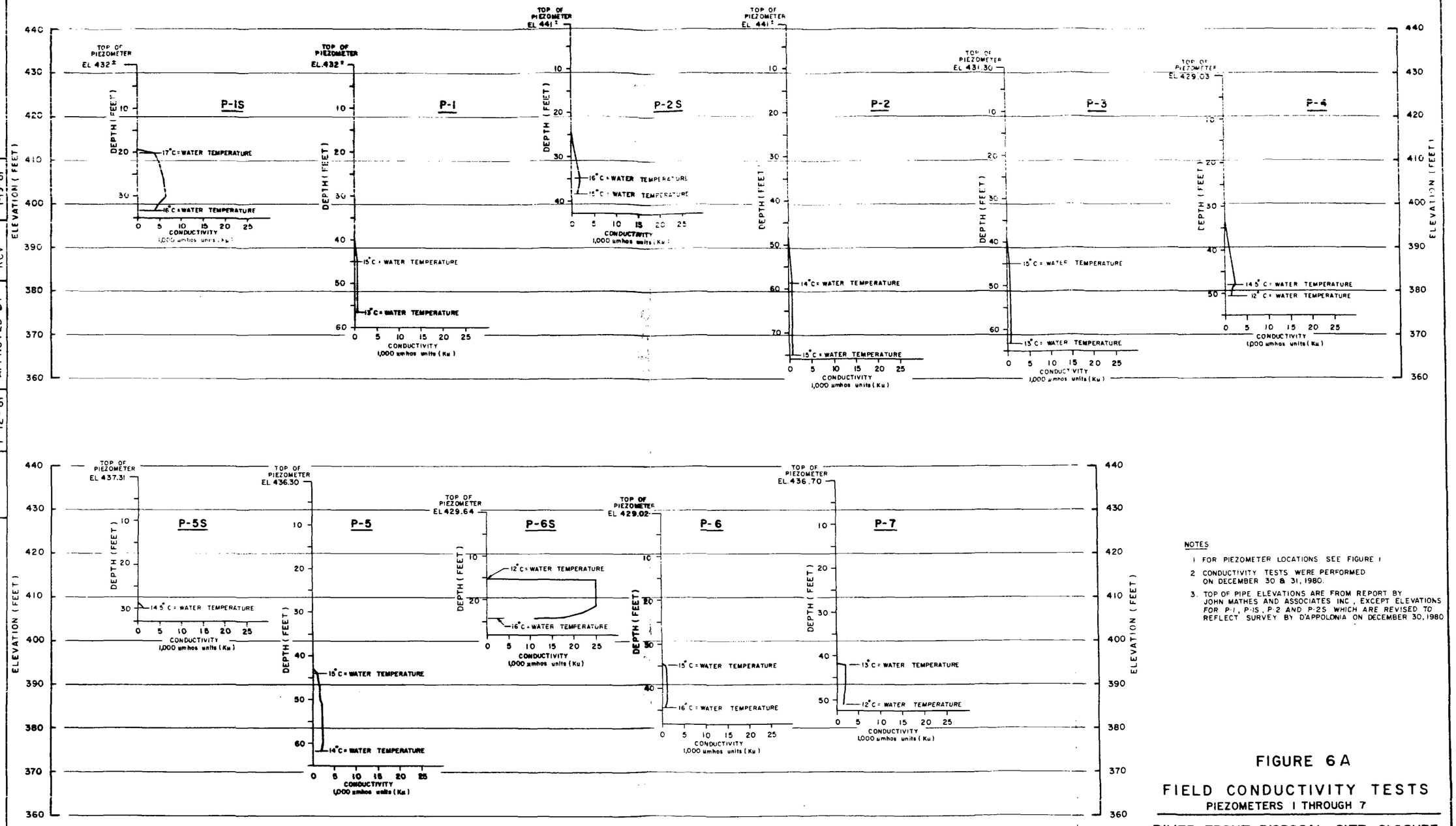
SAMPLE NO. 5
GRAIN SIZE ANALYSIS
BARTON BROWN SILT
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE D'APPOLONIA

DRAWN BY	DWD	CHECKED BY	SD	1-13-81	DRAWING NUMBER	MW 80-857-E15
	1-12-81	APPROVED BY	RCV	1-13-81		



NOTES

1. FOR PIEZOMETER LOCATIONS SEE FIGURE 1
2. CONDUCTIVITY TESTS WERE PERFORMED ON DECEMBER 30 & 31, 1980.
3. TOP OF PIPE ELEVATIONS ARE FROM REPORT BY JOHN MATHES AND ASSOCIATES INC., EXCEPT ELEVATIONS FOR P-1, P-1S, P-2 AND P-2S WHICH ARE REVISED TO REFLECT SURVEY BY D'APPOLONIA ON DECEMBER 30, 1980

FIGURE 6A

FIELD CONDUCTIVITY TESTS
PIEZOMETERS 1 THROUGH 7

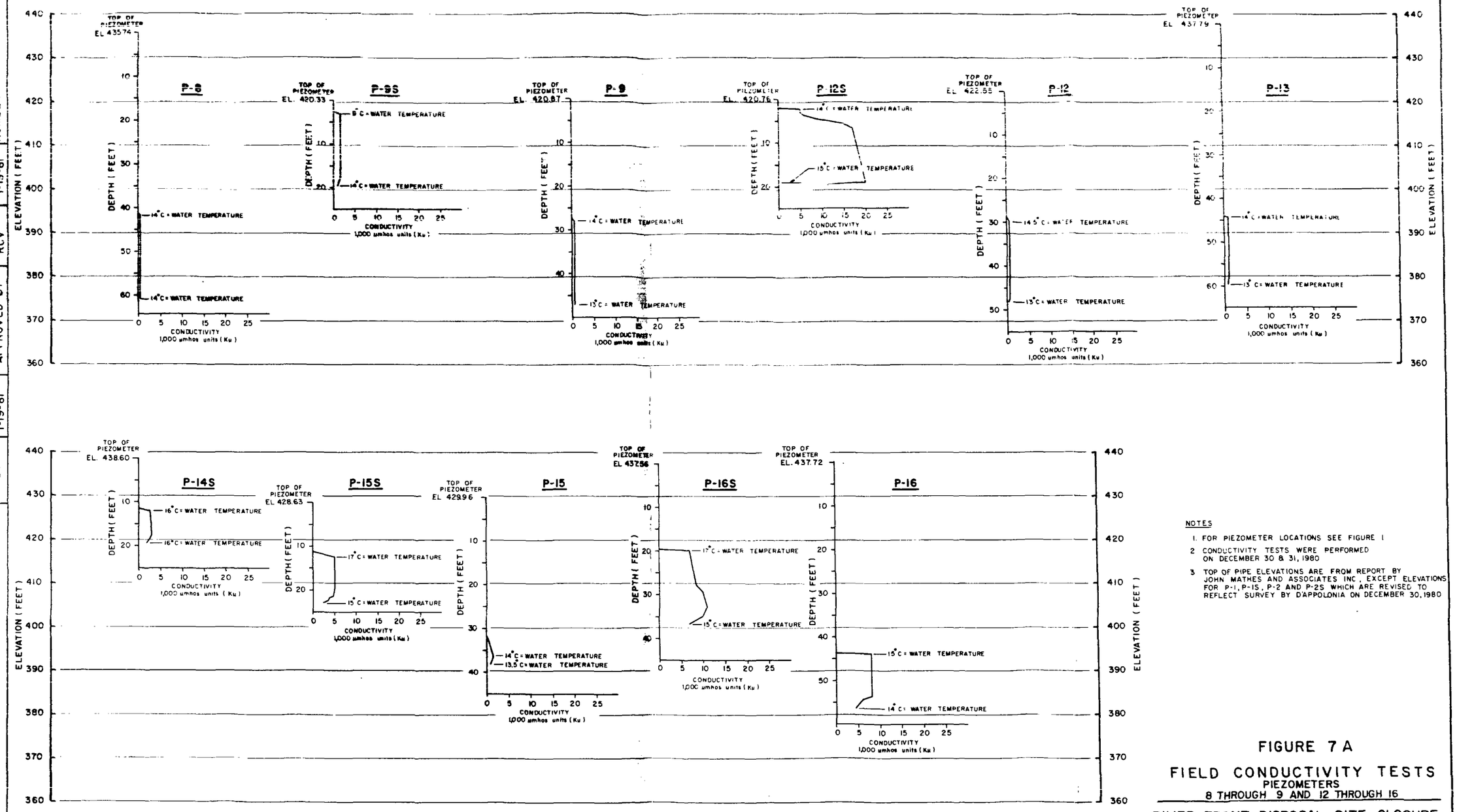
RIVER FRONT DISPOSAL SITE CLOSURE

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

EST. 81-8 DATE 1-23-81

CANONIE D'APPOLONIA



NOTES

1. FOR PIEZOMETER LOCATIONS SEE FIGURE 1
2. CONDUCTIVITY TESTS WERE PERFORMED ON DECEMBER 30 & 31, 1980
3. TOP OF PIPE ELEVATIONS ARE FROM REPORT BY JOHN MATHES AND ASSOCIATES INC., EXCEPT ELEVATIONS FOR P-1, P-15, P-2 AND P-2S WHICH ARE REVISED TO REFLECT SURVEY BY D'APPOLONIA ON DECEMBER 30, 1980

FIGURE 7 A

FIELD CONDUCTIVITY TESTS
PIEZOMETERS
8 THROUGH 9 AND 12 THROUGH 16

RIVER FRONT DISPOSAL SITE CLOSURE

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

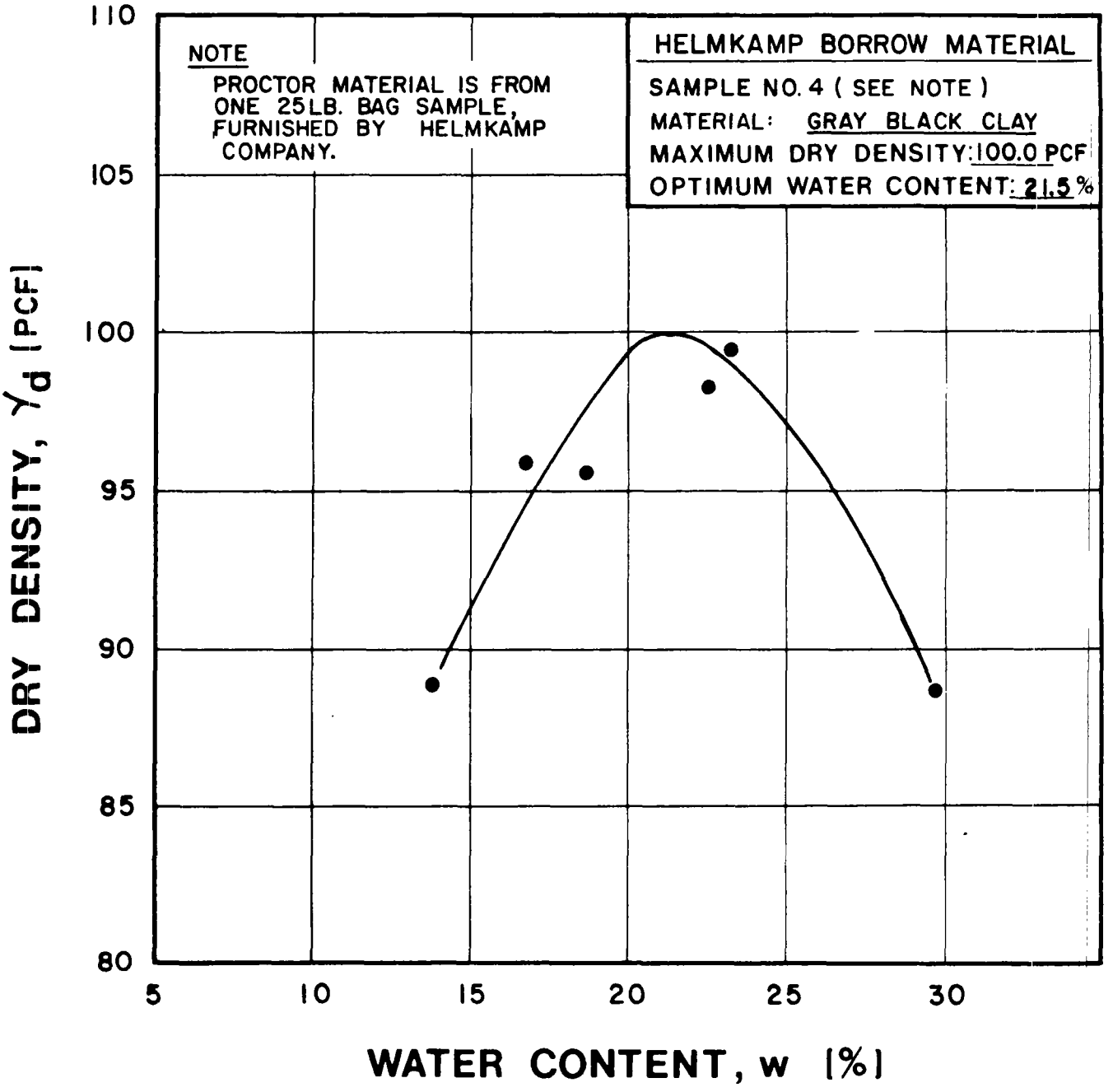
EST. 81-8

DATE 1-23-81

CANONIE D'APPOLONIA

DRAWN BY	WJ	1-19-81	DRAWING NUMBER	MW80-857-E16
CHECKED BY	SD	1-19-81		
APPROVED BY	RCV	1-19-81		

DRAWN BY	WJ	CHECKED BY	CC	DRAWING NUMBER	MW80-857-A5
	1-20-81	APPROVED BY	RCV		2-1-81



ASTM DESIGNATION USED D698

**METHOD USED A

ASTM DESIGNATION	HAM./DROP	LAYERS
STANDARD-D698	5.5#/ 12"	3
MODIFIED-D1557	10#/ 18"	5

METHOD**	MATERIAL SIZE	MOLD SIZE	BLOWS*
A	ALL PASSING #4	4" DIA.	25
B	ALL PASSING #4	6" DIA.	56
C	ALL PASSING 3/4"	4" DIA.	25
D	ALL PASSING 3/4"	6" DIA.	56

*BLOWS/LAYER

FIGURE 8A

STANDARD PROCTOR
MOISTURE-DENSITY RELATIONSHIP
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
D'APPOLONIA

DRAWN BY	WJ	CHECKED BY	CC	1-26-81	DRAWING NUMBER MW80-857-A6
	1-20-81	APPROVED BY	RCV	2-1-81	

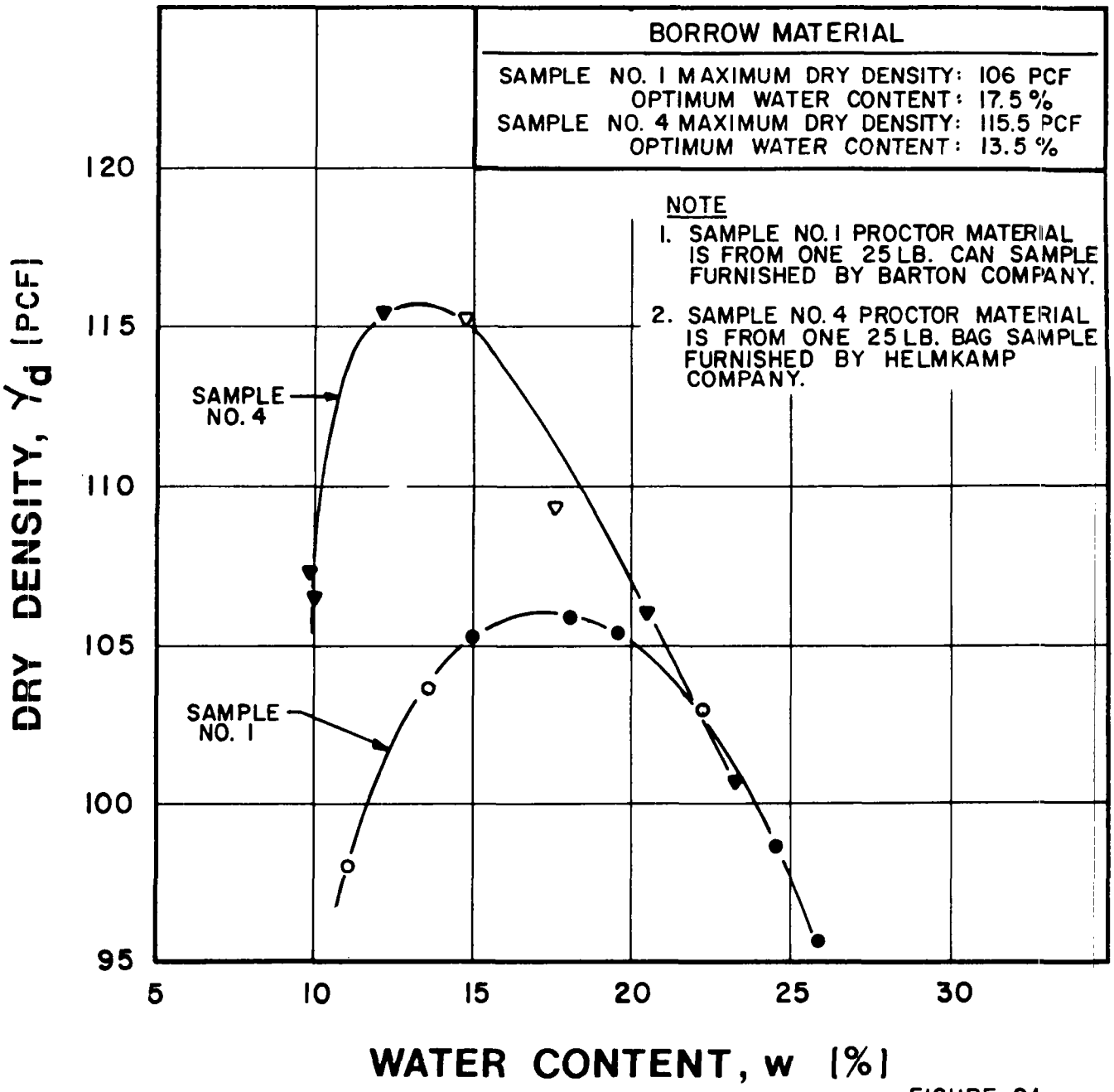


FIGURE 9A

LEGEND

- ● SAMPLE NO. 1 (BARTON BLACK CLAY)
- ○ SAMPLE NO. 1 (RECOMPACTED)
- ▼ SAMPLE NO. 4 (HELMKAMP GRAY BLACK CLAY)
- ▽ SAMPLE NO. 4 (RECOMPACTED)

ASTM DESIGNATION USED D 1557

**METHOD USED A

ASTM DESIGNATION	HAM./DROP	LAYERS
STANDARD-D698	5.5#/ 12"	3
MODIFIED-D1557	10#/ 18"	5

METHOD**	MATERIAL SIZE	MOLD SIZE	BLOWS*
A	ALL PASSING #4	4" DIA.	25
B	ALL PASSING #4	6" DIA.	56
C	ALL PASSING 3/4"	4" DIA.	25
D	ALL PASSING 3/4"	6" DIA.	56

*BLOWS/LAYER

MODIFIED PROCTOR
MOISTURE-DENSITY RELATIONSHIP
BORROW MATERIAL FOR CLAY CAP

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
D'APPOLONIA

DRAWN BY	WJ	CHECKED BY	CC	DRAWING NUMBER MW80-857-A14
	2-1-81	APPROVED BY	RCV	
			2-1-81	

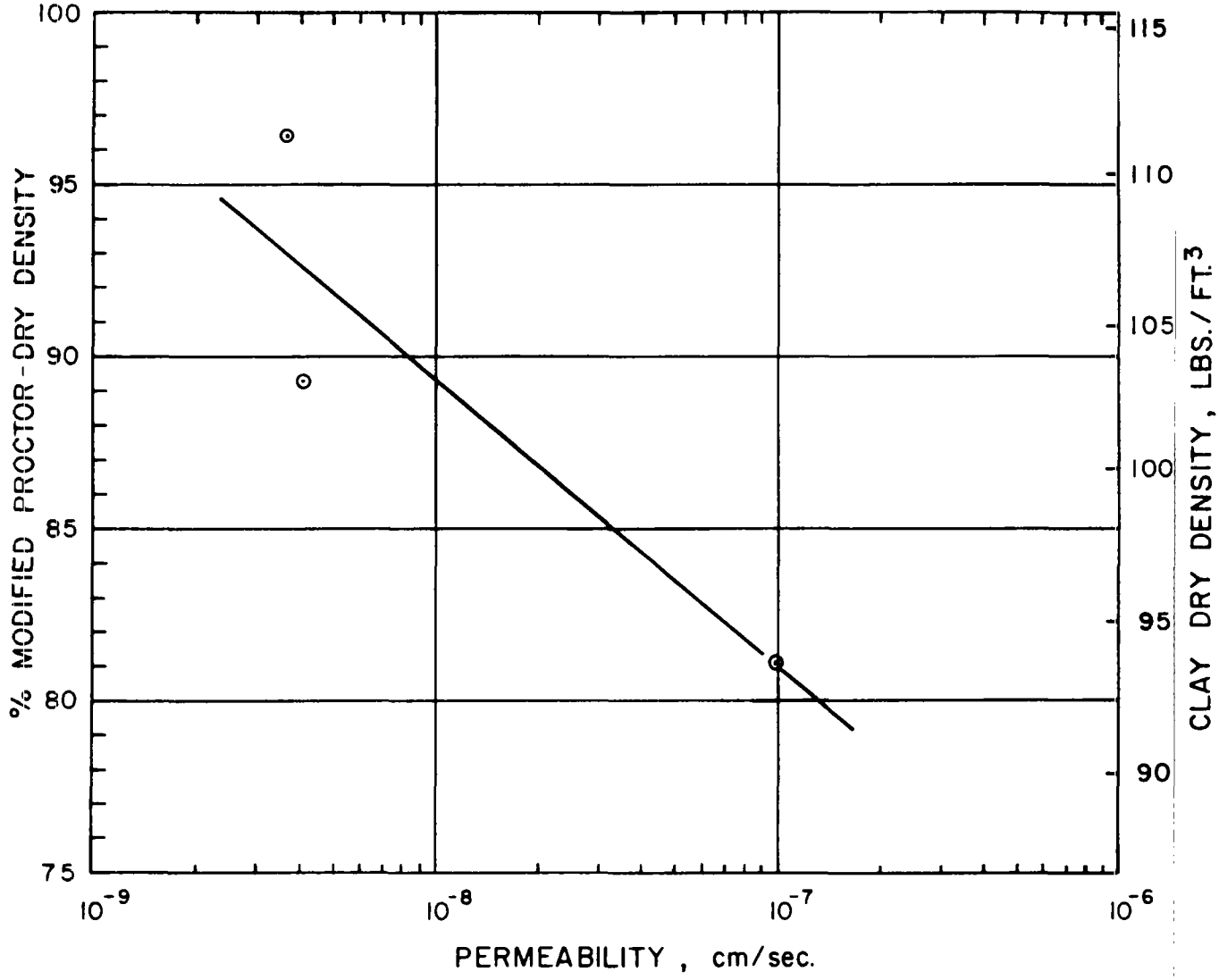


FIGURE 10A

RELATIONSHIP BETWEEN PERMEABILITY AND MODIFIED PROCTOR DRY DENSITY BORROW MATERIAL FOR CLAY CAP SAMPLE NO. 4

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE D'APPOLONIA

19 1253 HERCULENE A&B SMITH CO PGH PA LT1530-1079

DRAWN BY	MYM	CHECKED BY	CC	2-1-81	DRAWING NUMBER	MW80-6117-81
	1-30-81	APPROVED BY	RCV	2-1-81		

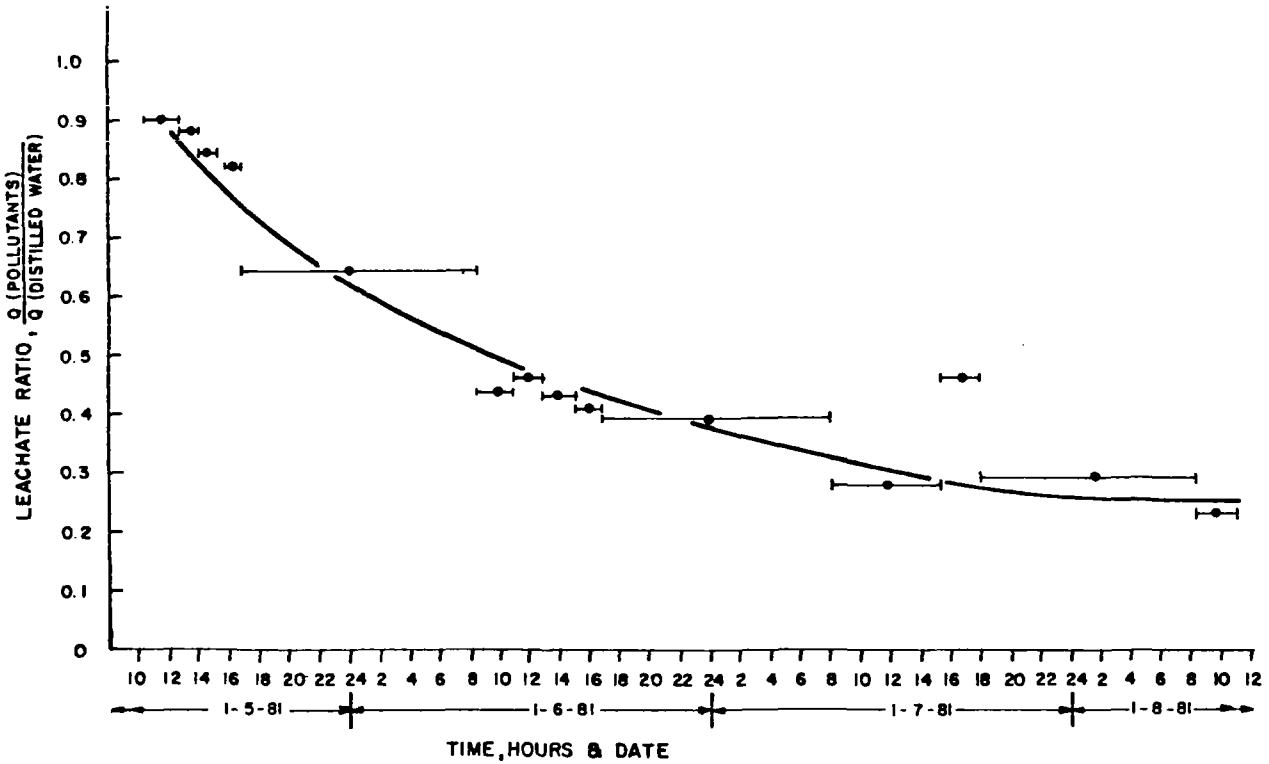


FIGURE 11A

BENTONITE FILTER
CAKE TEST NO. 1
RATIO OF LEACHATES VS TIME

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

GANONIE
DAPPOLONIA

10 1255 HERCULES 600 BRITH CO PGH PA LT-1530-1070

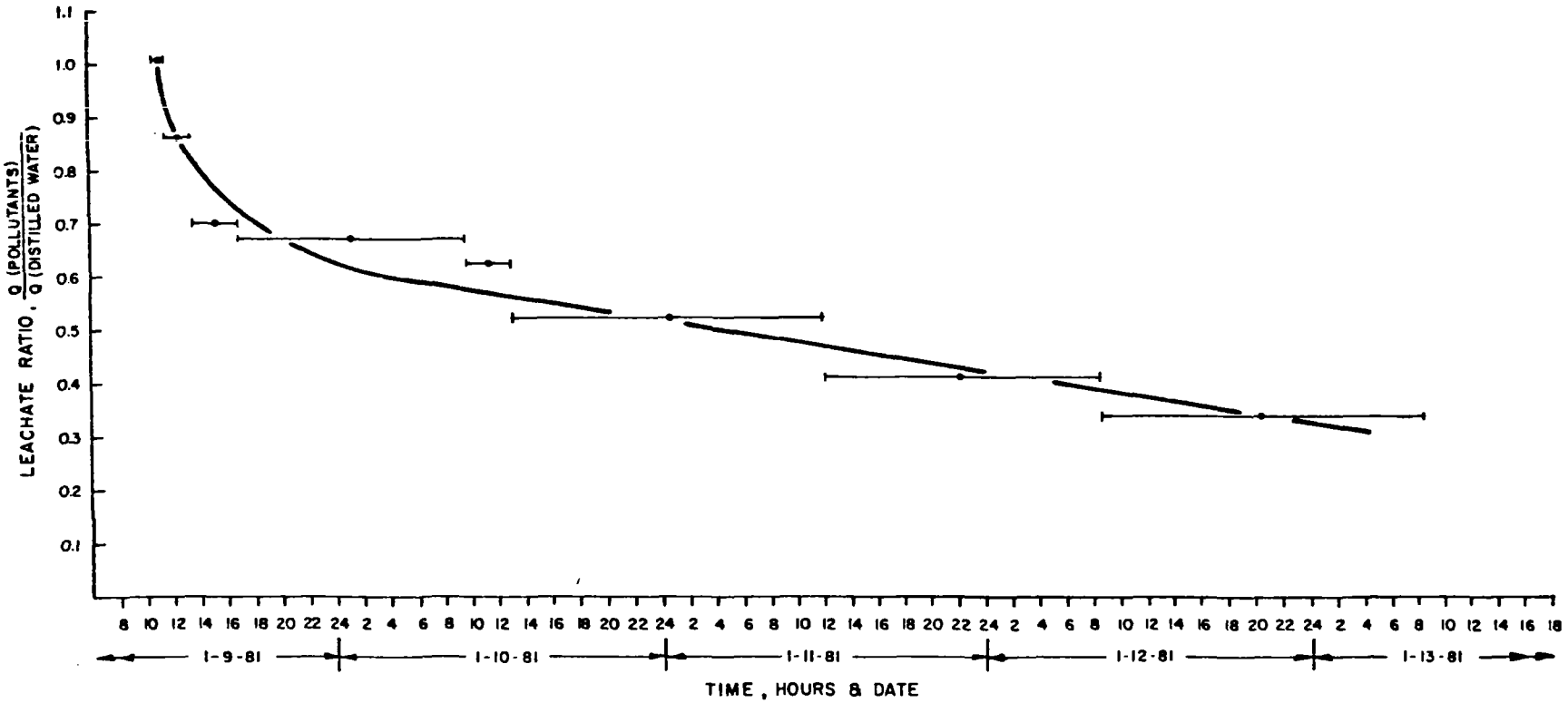


FIGURE 12A

BENTONITE FILTER
CAKE TEST NO. 2
RATIO OF LEACHATES VS. TIME

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
DAPPOLONIA

DRAWN BY	W.J.	CHECKED BY	CJC	2-1-81	DRAWING NUMBER MW80-1157-B2
	1-30-81	APPROVED BY	HCV	2-1-81	

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DRAWN BY	RJN 1-30-81	CHECKED BY	CC 2-1-81	DRAWING NUMBER	MW80-817-83
		APPROVED BY	RCV 2-1-81		

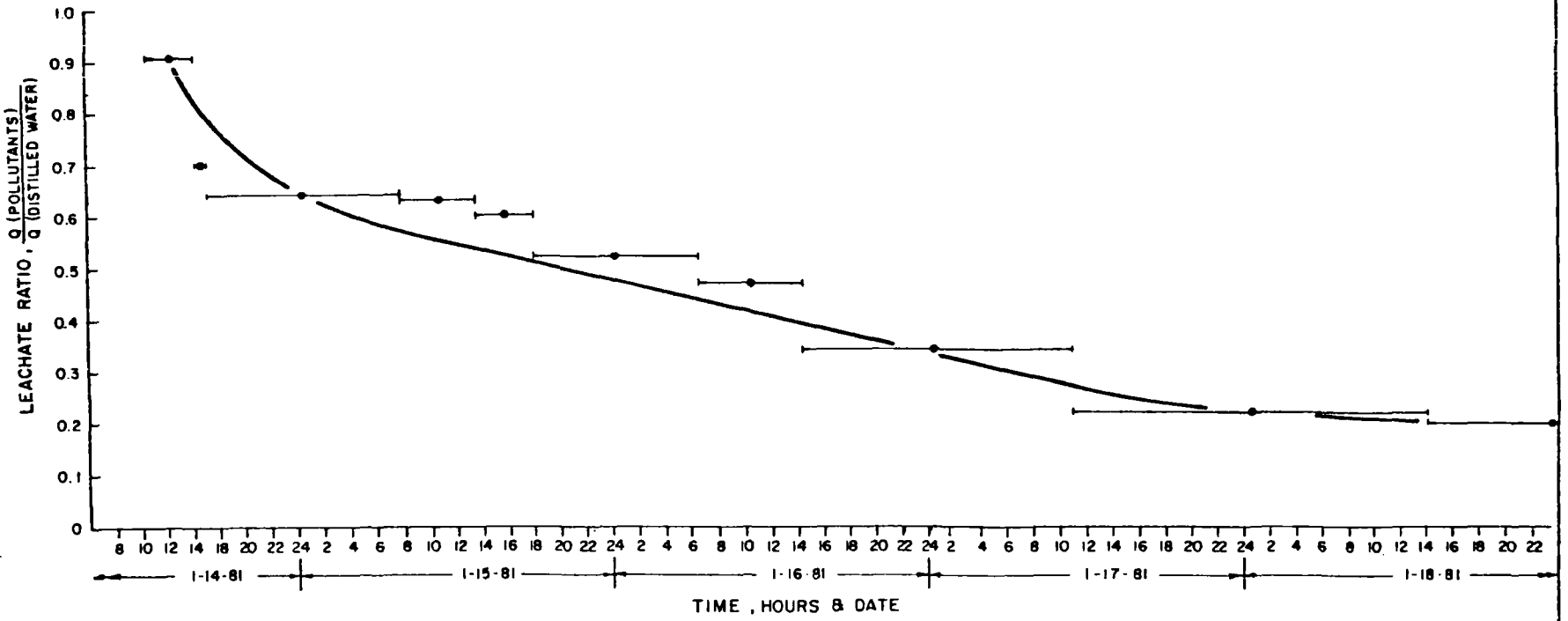

FIGURE 13A

BENTONITE FILTER
CAKE TEST NO. 3
RATIO OF LEACHATES VS. TIME

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

CANONIE
DAIPOLONIA

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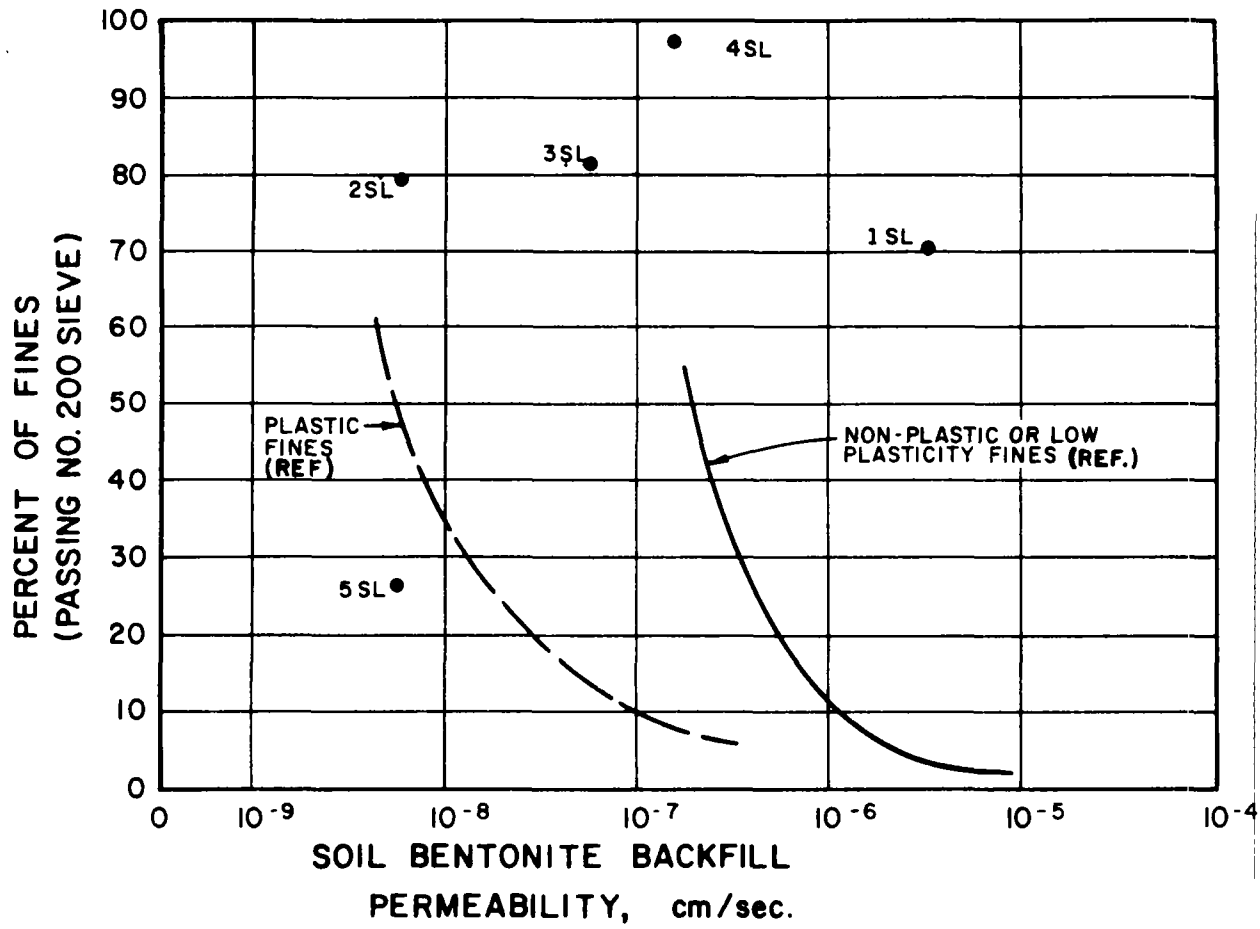
DRAWN BY	RJN 1-30-81	CHECKED BY	CC 2-1-81	DRAWING NUMBER	MW80-857-A12
		APPROVED BY	RCV 2-1-81		



LABORATORY TEST RESULTS

SAMPLE NO.	% PASSING NO. 200 SIEVE	PERMEABILITY, cm/sec.
1 SL	70.2	3.1×10^{-6}
2 SL	79.3	5.9×10^{-9}
3 SL	82.66	5.3×10^{-8}
4 SL	97.45	1.5×10^{-7}
5 SL	26.4	5.8×10^{-9}

FIGURE 14A

PERMEABILITY OF SOIL-BENTONITE BACKFILL RELATED TO FINES CONTENT

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

REFERENCE

D.J. D'APPOLONIA, "SOIL BENTONITE SLURRY TRENCH CUTOFFS" JOURNAL OF THE GEOTECHNICAL ENG. DIV. APR. 1980, ASCE

CANONIE D'APPOLONIA

19 1253 HERCULENE A&B SMITH CO PGH PA LT1530-1079

DRAWN BY	RJN/MTM	CHECKED BY	CC	2-1-81	DRAWING NUMBER MW80-857-A10
	1-29-81	APPROVED BY	RCV	2-1-81	

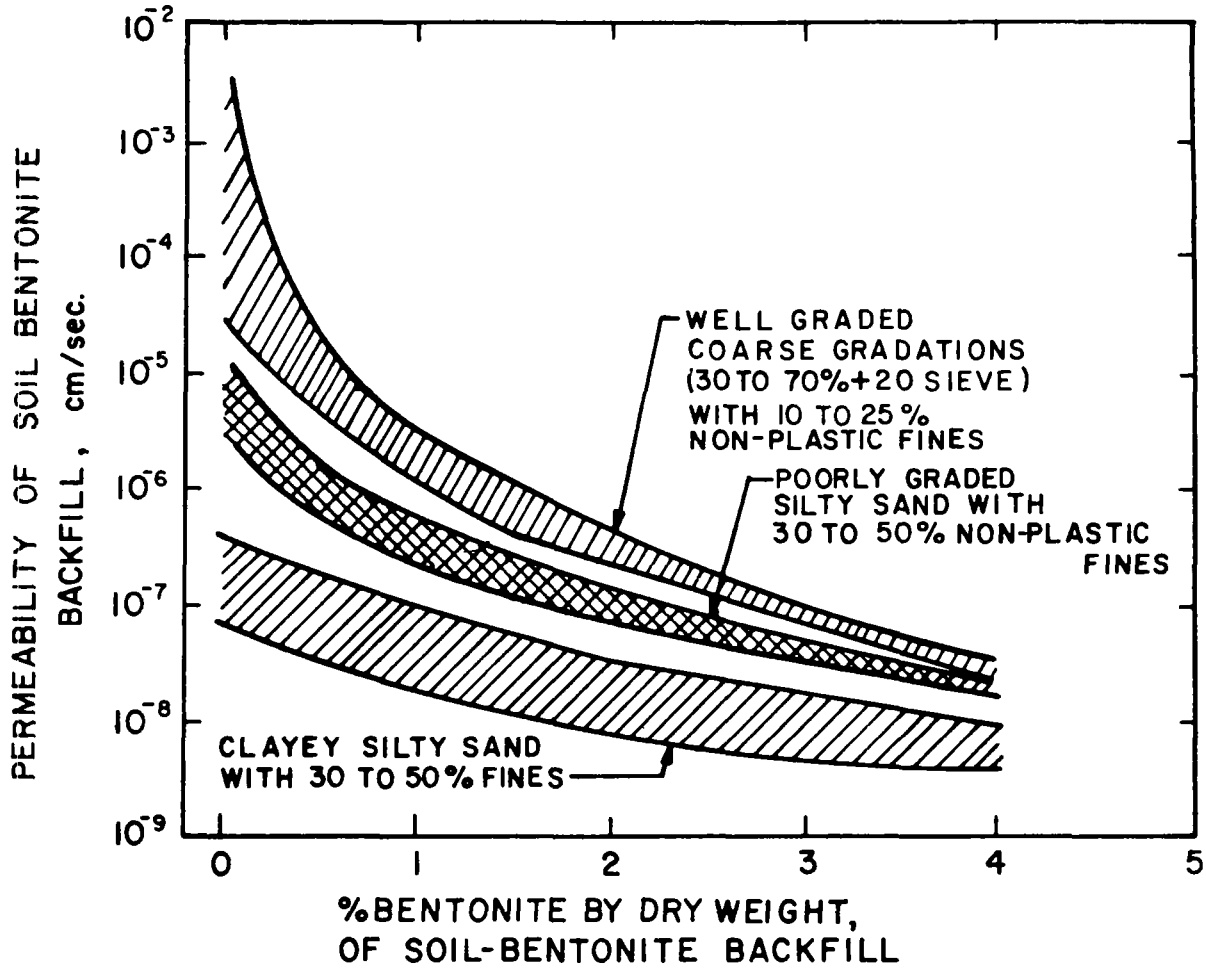


FIGURE 15A

RELATIONSHIP BETWEEN PERMEABILITY AND QUANTITY OF BENTONITE ADDED TO SOIL-BENTONITE BACKFILL

PREPARED FOR

AMOCO OIL COMPANY
WOOD RIVER, ILLINOIS

REFERENCE

D. J. D'APPOLONIA, "SOIL BENTONITE SLURRY TRENCH CUTOFFS" JOURNAL OF THE GEOTECHNICAL ENG. DIV. APR. 1980, ASCE

CANONIE D'APPOLONIA

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