7

APPENDICES

FOR

REMEDIAL INVESTIGATION
AND FEASIBILITY STUDY

AT THE

RAMAPO LANDFILL

ROCKLAND COUNTY

NYSDEC SITE NO. 3-44-004

TOWN OF RAMAPO, NEW YORK

SEPTEMBER 1991

PREPARED BY

URS Consultants, Inc.
282 Delaware Avenue
Buffalo, New York 14202

VOLUME 4 OF 4

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APPENDIX K

ENVIRONMENTAL SAMPLE DESCRIPTIONS

APPENDIX K.1

ENVIRONMENTAL SAMPLE DESCRIPTIONS

PHASE I

RAMAPO LANDFILL RI/FS - SAMPLE DATA

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
SPS-1	Waste	Moist clay, with sand, silt, and gravel, slight organic odor (0-3")	10/16/89	N-5496 E-5134	Location of high HNu readings during soil gas survey. Composite
SPS-2	Waste	Moist clay, with sand, silt, and gravel, slight sulfer odor (0-18")	10/16/89	N-4452 E-4850	Location of high HNu readings during soil gas survey. Composite
SPS-3	Waste	Wet silty clay with sand and gravel, gray (4-8")	10/15/89	N-3279 E-4261	Low area with surface flow to Torne Brook. Composite
SPS-4	Waste	Saturated silty soil, brown to black, some organics, oil sheen (0-4")	10/15/89	N-3898 E-4390	High HNu readings during soil gas survey. Oil odor noticed during survey. Composite
SPS-5	Waste	Hardened blue, rust, and brown paint sludge over soil (0-8") slight paint odor	10/16/89	N-5629 E-4851	Paint like waste exposed on surface.
SPS-6	Surface soil	Moist silt, sand, and gravel, brown (0-8")	10/27/89	N-4710 E-4530	Composite of several locations around weigh station to assess health risk to employees.
SPS-7	Surface soil	Moist silt, sand, and gravel, brown (0-8")	10/17/89	N-2810 E-4200	Composite of several locations around leachate treatment facility to assess health risk to employees/tresspassers.
SPS-8	Surface soil	Moist silty clay with sand and gravel, some organics (0-8")	10/17/89	N-4565 E-5940	Composite of several locations at pistol range to assess health risk to users.
SPS-9	Surface soil	Moist dark brown silty clay with sand and gravel (0-8")	10/17/89	N-4090 E-5325	Background soil sample. Composite

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
SPS-10	Surface soil	Saturated silty clay with sand, brown (0-8")	10/17/89	N-4835 E-6065	Composite of several locations around bailer building to assess health risk to employees and visitors.
SW-LS-1	Leachate seep	Slightly turbid water, slight odor	10/23/89	N-4604 E-4559	Large volume leachate stream draining large area.
SW-LS-2	Leachate seep	Turbid to highly turbid water, moderate odor	10/23/89	N-5179 E-4816	Large volume leachate outbreak.
SW-1	Surface water	Slightly turbid water, slight odor	10/25/89	N-2915 E-3810	Ramapo River at location of treated leachate outfall.
SW-2	Surface water	Clear water	10/26/89	N-5925 E-5860	Background surface water sample (Torne Brook).
SW-3	Surface water	Clear water	10/26/89	N-3400 E-4150	Torne Brook at leachate system storm overflow
SW-4	Surface water	Slightly turbid water	10/26/89	N-2175 E-4065	Confluence of two small streams draining southern property line area.
SS-1	Stream sediment	Sandy stream sediments, tan	10/25/89	N-2915 E-3810	Taken in conjunction with SW-1. Composite
SS-2	Stream sediment	Lt. brown fine gravel, and fine sand	10/26/89	N-5925 E-5860	Taken in conjunction with SW-2. Composite
SS-3	Stream sediment	Brown, fine sand and gravel	10/26/89	N-3400 E-4150	Taken in conjunction with SW-3. Composite
SS-4	Stream sediment	Brown, fine sand and gravel	10/26/89	N-2175 E-4065	Taken in conjunction with SW-4. Composite
MW-1-SB (11-13')	Subsurface soil	Silty sand, some gravel and clay, dense, brown	11/15/89	N-5020 E-4530	Unsaturated soil above water table at well cluster 1. Composite
MSW-2-SB (7-9')	Subsurface soil	Silty sand, some gravel, trace clay, brown, very dense	12/17/89	N-5510 E-4975	Unsaturated soil above water table at well cluster 2. Composite

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
MW-3-SB (6-10')	Subsurface soil	Sand, some silt; and gravel, trace clay, medium dense, grey to brown	11/16/89	N-4315 E-4177	Unsaturated soil above water table at well pair 3. Composite
MW-4-SB (1-4')	Subsurface soil	Silty sand, some gravel, trace clay, red brown, medium dense	11/30/89	N-5772 E-5570	Unsaturated soil above water table at well cluster 4. Composite
MW-5-SB (4-6')	Subsurface soil	Silty sand with some to trace gravel, trace clay, brown, medium dense	12/5/89	N-4118 E-5787	Unsaturated soil above water table at well cluster 5. Composite
MW-7-SB (4-8')	Subsurface soil	Sand and gravel, trace silt, brown, loose	10/16/89	N-2716 E-4195	Unsaturated soil above water table at well cluster 7. Composite
MW-8-SB (8-12')	Subsurface soil	Sandy gravel, some silt, trace clay, dense, grey	11/7/89	N-3522 E-4142	Unsaturated soil above water table at well cluster 8. Composite
GW-1-OS	Groundwater	Clear, turning turbid as volume drawn increases. No Odor.	1/25/90	N-5009 E-4523	Shallow GW monitoring/spacial distribution.
GW-1-I	Groundwater	Clear, turning light brown as volume drawn increases. No Odor	1/25/90	N-5020 E-4535	Intermediate groundwater monitoring/spacial distribution.
GW-1-R	Groundwater	Clear, turning light brown as volume drawn increases. No Odor	1/25/90	N-5016 E-4530	Bedrock groundwater monitoring/spacial distribution.
GW-2-OS	Groundwater	Very slightly turbid. No Odor	1/24/90	N-5521 E-4980	Shallow groundwater monitoring/downgradient of high soil gas readings.
GW-2-I	Groundwater	Clear, No Odor	1/26/90- 1/27/90	N-5509 E-4978	Intermediate groundwater monitoring/downgradient of high soil gas readings.
GW-2-R	Groundwater	Clear, No Odor	1/24/90	N-5507 E-4969	Bedrock groundwater monitoring.

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
GW-3-I/OS	Groundwater	Clear, No Odor	1/26/90	N-4310 E-4176	Shallow groundwater monitoring/intersection of two major linear trends identified in fracture trace analysis.
GW-3-R	Groundwater	Clear, No Odor	1/26/90	N-4321 E-4177	Bedrock groundwater monitoring/intersection of two major linear trends identified in fracture tract analysis.
GW-4-OS	Groundwater	Clear to turbid, light brown sediment. No Odor	1/25/90	N-5785 E-5555	Shallow groundwater monitoring/high conc. of BTX and high specific conductivity from previous studies.
GW-4-I	Groundwater	Clear with increasing turbidity as volume drawn increased. No Odor	1/25/90	N-5772 E-5566	Intermediate groundwater monitoring/high conc. of BTX and high specific conductivity from previous studies.
GW-4-R	Groundwater	Clear turning slightly turbid with light brown sediment. No Odor	1/25/90	N-5766 E-5572	Bedrock groundwater monitoring/high conc. of BTX and high specific conductivity from previous studies.
GW-5-OS	Groundwater	Clear, No Odor	1/27/90	N-4124 E-5795	Shallow groundwater monitoring/background.
GW-5-I	Groundwater	Clear, No Odor	1/27/90	N-4109 E-5781	Intermediate groundwater monitoring/background.
GW-5-R	Groundwater	Clear, No Odor	1/27/90	N-4118 E-5787	Bedrock groundwater monitoring/background.
GW-7-OS	Groundwater	Clear (VOA & Metals) turbid for all other parameters. No Odor	1/25/90	N-2726 E-4195	Shallow groundwater monitoring near leachate treatment pond.

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
GW-7-I	Groundwater	Clear, No Odor	1/25/90	N-2706 E-4194	Intermediate groundwater monitoring near leachate treatment pond.
GW-7-R	Groundwater	Clear, No Odor	1/25/90	N-2716 E-4197	Bedrock groundwater monitoring near leachate treatment pond.
GW-8-OS	Groundwater	Turbid with sediment and floaters. No Odor	1/26/90	N-3506 E-4150	Shallow groundwater monitoring/elevated mercury and BTX from previous studies.
GW-8-I	Groundwater	Clear turning slightly turbid as volume drawn increases. Slight odor.	1/26/90	N-3539 E-4135	Intermediate groundwater monitoring/elevated mercury and BTX from previous studies.
GW-8-R	Groundwater	Clear, No Odor	1/26/90	N-3526 E-4146	Bedrock groundwater monitoring/elevated mercury and BTX from previous studies.
RB-1	QA/QC	Rinse Blank	10/15/89	---	Wash from mixing bowl after decon. (SPS-3)
RB-2 10/25/89	QA/QC	Rinse Blank	10/25/89	---	Wash from sampling equipment used for stream sediment sampling (SS-1).
RB-2 11/7/89	QA/QC	Rinse Blank	11/7/89	---	Wash after decon of sampling equipment used for MW-8-SB.
RL-RB-GW	QA/QC	Rinse Blank	1/26/90	---	Wash after decon of sampling equipment used for groundwater sampling.
SPS-3 MS/MSD	QA/QC	Matrix Spike Matrix Spike Duplicate	10/15/89	N-3279 E-4261	QA/QC
MW-4-SB MS/MSD	QA/QC	Matrix Spike Matrix Spike Duplicate	11/30/89	N-5772 E-5570	QA/QC

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason for Location
GW-8-OS MS/MSD	QA/QC	Matrix Spike Matrix Spike Duplicate	1/26/90	N-3506 E-4150	QA/QC
GW-7-R MS/MSD	QA/QC	Matrix Spike Matrix Spike Duplicate	1/25/90	N-2716 E-4197	QA/QC
Drill-1	QA/QC	Clear White Water	10/18/89	---	Drill water from source hose of CME-75.
Drill-2	QA/QC	Clear White water	11/28/89	---	Drill water from source hose of GUSPECH.
Drill-3	QA/QC	Clear White Water	12/5/89	---	Drill water from source hose of D-50.
TB-1	QA/QC	Trip Blank	10/18/89	---	Trip Blank for Drill-1.
TB-3	QA/QC	Trip Blank	1/24/89	---	Trip Blank for Groundwater Samples.
SW-LS-TB3	QA/QC	Trip Blank	10/23/89	---	Trip Blank for Leachate Seep Samples.
TB-4	QA/QC	Trip Blank	10/25/89	---	Trip Blank for Surface Water Samples.
MW-TB-GW	QA/QC	Trip Blank	1/26/90	---	Trip Blank for Groundwater Samples.
TB-2	QA/QC	Trip Blank	1/25/90	---	Trip Blank for Groundwater Samples.

APPENDIX K.2

ENVIRONMENTAL SAMPLE DESCRIPTIONS

PHASE II AND RE-SAMPLING FOR PHASE I

RAMAPO LANDFILL RI/FS RE-SAMPLING OF PHASE I LOCATIONS

SAMPLE ID	SAMPLE TYPE	DESCRIPTION	DATE SAMPLED	GRID LOCATION	REASON FOR LOCATION
GW-4-OS	groundwater	slightly turbid to turbid, no odor	7-24-90	N-5785 E-5555	Re-sample for Phase I
SPS-6	surface soil	brown medium sand w/topsoil, no odor	7-24-90	N-4710 E-4530	Re-sample for Phase I, composite
SW-1	surface water	clear w/similar odor as leachate pond, strong flow on River from outfall pipe	7-20-90	N-2915 E-3810	Re-sample for Phase I PCB/Pest
SW-2	surface water	----	---	---	See SW-5
SW-3	surface water	clear w/slight sewer odor, water had no flow. Sampled pool at 6" deep at the leachate collector's overflow	7-20-90	N-3400 E-4150	Re-sample for Phase semi's + PCB/Pest
SW-4	surface water	clear to slightly turbid w/high organic debris and floaters in sample	7-20-90	N-2175 E-4065	Re-sample for Phase I semi's + PCB/Pest
SS-1	stream sediment	brown fine sand w/fractured gravel and some organic debris	7-20-90	N-2915 E-3810	OC + Re-sample for Phase I semi's + PCB/ Pest, composite
SS-2	stream sediment	----	---	---	see SS-5, composite
SS-3	stream sediment	brown fine sand w/fractured gravel, moderate sewage odor	7-20-90	N-3400 E-4150	OC + Re-sample for Phase I semi's + PCB/ Pest, composite
SS-4	stream sediment	brown fine sand w/some gravel and organic debris, slight odor	7-20-90	N-2175 E-4065	OC + Re-sample for Phase I semi's + PCB/ Pest, composite

RAMAPO LANDFILL RI/FS - PHASE II SAMPLE DATA

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason For Location
GW-1-OS	Groundwater	very slightly turbid to turbid, no odor	9-13-90	N-5009 E-4523	second round of sampling
GW-1-I	Groundwater	clear, no odor	9-13-90	N-5020 E-4535	second round of sampling
GW-1-R	Groundwater	slightly turbid, no odor	9-13-90	N-5016 E-4530	second round of sampling
GW-2-OS	Groundwater	slightly turbid w/no odor (VOA + metals), turning turbid	9-13-90	N-5521 E-4980	second round of sampling
GW-2-I	Groundwater	clear, no odor	9-13-90	N-5509 E-4978	second round of sampling
GW-2-R	Groundwater	clear, no odor	9-13-90	N-5507 E-4969	second round of sampling
GW-3-I/OS	Groundwater	clear for first 3 bailers (VOA + metals) turning turbid as well dried, no odor	9-13-90	N-4310 E-4176	second round of sampling
GW-3-R	Groundwater	clear for first 3 bailers (VOA + metals), turning turbid w/no odor	9-13-90	N-4321 E-4177	second round of sampling
GW-4-OS	Groundwater	turbid, no odor	9-14-90	N-5785 E-5555	second round of sampling
GW-4-I	Groundwater	clear, no odor	9-14-90	N-5772 E-5566	second round of sampling
GW-4-R	Groundwater	clear, no odor	9-14-90	N-5766 E-5572	second round of sampling
GW-5-OS	Groundwater	clear (VOA + metals) turning highly turbid, no odor	9-15-90	N-4124 E-5795	second round of sampling
GW-5-I	Groundwater	turbid, no odor (VOA + metals)	9-15-90	N-4109 E-5781	second round of sampling

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason For Location
GW-5-R	Groundwater	clear, no odor	9-15-90	N-4118 E-5787	second round of sampling
GW-6-OS	Groundwater	clear to very slightly turbid w/suspended mica as muscovite particulate	9-15-90	N-5670 E-5851	shallow groundwater monitoring outside leachate collection system
GW-6-I	Groundwater	clear, no odor	9-15-90	N-5670 E-5832	intermediate groundwater monitoring outside leachate collection system
GW-6-R	Groundwater	clear, no odor	9-15-90	N-5688 E-5823	bedrock groundwater monitoring outside leachate collection system
GW-7-OS	Groundwater	clear to highly turbid, no odor	9-11-90	N-2727 E-4195	second round of sampling
GW-7-I	Groundwater	clear to slightly turbid, H_2S odor (VOA + metals)	9-11-90	N-2707 E-4195	second round of sampling
GW-7-R	Groundwater	clear, no odor	9-11-90	N-2716 E-4198	second round of sampling
GW-8-OS	Groundwater	clear turning turbid w/orange globs of bottom settlings material-no odor	9-12-90	N-3507 E-4151	second round sampling
GW-8-I (MS/MSD) + (VOA FD)	Matrix spike Matric spike duplicate Field duplicate (VOA only)	slightly turbid w/moderate odor, sample had a foamy/effervescent appearance	9-12-90	N-3539 E-4135	second round of sampling
GW-8-R	Groundwater	slightly turbid (VOA + metals), turning turbid w/no odor	9-12-90	N-3526 E-4146	second round sampling

RAMAPO LANDFILL RI/FS - PHASE II SAMPLE DATA

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason For Location
GW-9-OS	Groundwater	clear, no odor, - EPA Split-	9-14-90	N-3445 E-3925	shallow groundwater monitoring well located offsite between landfill and PW-1
GW-9-I	Groundwater	clear, no odor, - EPA Split-	9-14-90	N-3435 E-3922	intermediate groundwater monitoring well located offsite between landfill and PW-1
GW-9-R (MS/MSD) + (VOA FD)	Matrix spike Matrix spike duplicate, Field duplicate (VOA only)	clear, no odor, first bailer had discoloration - EPA Split -	9-14-90	N-3459 E-3931	bedrock groundwater monitoring well located offsite between landfill and PW-1
GW-10-OS split sample with ACCE	Groundwater	clear to slightly turbid to clear, no odor	9-12-90	N-2326 E-4102	shallow groundwater monitoring well located offsite near southern edge between landfill and Ramapo River
GW-10-R split sample with ACCE	Groundwater	very slightly turbid, no odor	9-14-90	N-2822 E-4019	bedrock groundwater monitoring well located offsite near southern edge between landfill and Ramapo River
GDT-1	Tap water	clear, no odor	9-14-90		residential well
GT-1	Surface soil	gravelly soil, silty, dry, roots	8-2-90	see Fig.	southern edge of property beyond limits of fill

RAMAPO LANDFILL RI/FS - PHASE II SAMPLE DATA

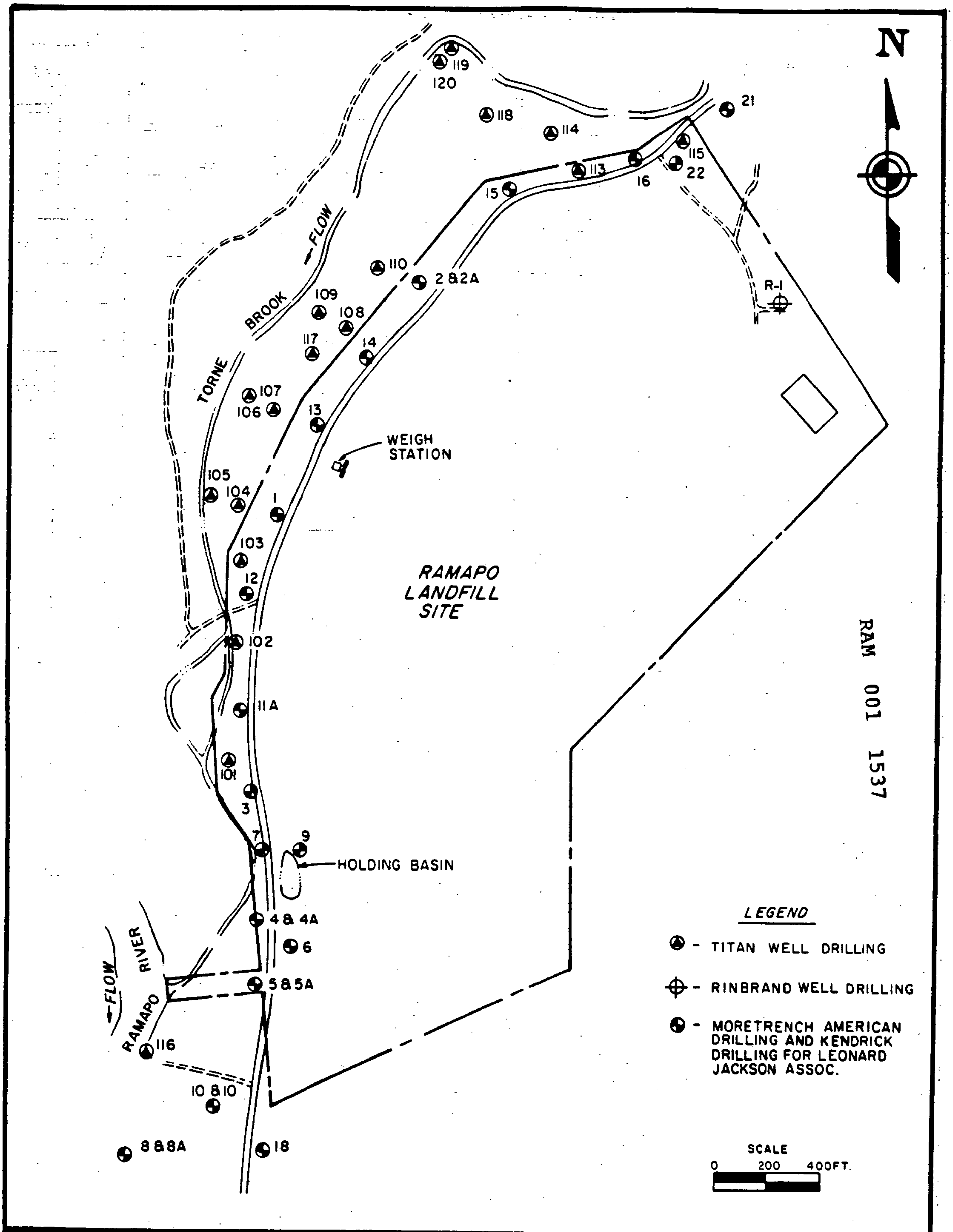
Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason For Location
GT-2	Surface soil 0-2"	black oganic-rich topsoil, silty, some fine sand, dry	8-2-90	see Fig.	southern lobe
GT-3	Surface soil 0-2"	silty topsoil, some cobbles and gravel, dry, roots	8-2-90	see Fig.	swale between northern and southern lobes
GT-4	Surface soil 0-2"	silty topsoil w/some cobbles and gravel, dry	8-2-90	see Fig.	northern end of property beyond fill limits
GT-5	Surface soil 0-2"	silty topsoil w/some cobbles and gravel, dry	8-2-90	see Fig.	eastern edge past Pistol Range
GT-6	Surface soil 0-2"	silty topsoil w/gravel, roots	8-2-90	see Fig.	northern lobe
SW-5	surface water	clear w/no odor, background sample taken in area of moderate flow	7/20/90		upstream sample along Torne Brook
SW-6	surface water	clear, no odor, good flow	7-20-90		along Torne Brook
SW-7	surface water	clear, no odor, good flow	7-20-90		along Torne Brook
SW-8	surface water	clear, no odor, slow flow	7-20-90		along Torne Brook before split
SS-5	stream sediment	brown medium-fine sand w/some silt, gravel and organics, slight degradation	7-20-90		same location as SW-5, composite
SS-6	stream sediment	brown medium-fine sand and gravel w/some silt, no odor	7-20-90		same location as SW-6, composite
SS-7	stream sediment	brown gravel and sand w/trace silt, no odor	7-20-90		same location as SW-7, composite

RAMAPO LANDFILL RI/FS - PHASE II SAMPLE DATA

Sample ID	Sample Type	Description	Date Sampled	Grid Location	Reason For Location
SS-8	stream sediment	brown medium fine gravel and sand, trace silt and organics, slight odor	7-20-90		same location as SW-8, composite
LEF-1	leachate effluent	brown/orange, highly turbid w/strong sulfide odor	8-8-90		effluent from leachate pond for mass balance study
LIN-1	leachate influent	clear to slightly orange, strong sulfide odor	8-8-90		influent to leachate pond for mass balance study
LPSS-1	leachate pond sediment	black silt and very fine sand w/brown decayed moss and algae, slight odor	8-8-90		sediment within leachate pond
LS MW-10	surface soil	brown/orange highly turbid surface sheen	8-24-90		appeared to be a leachate seep near MW-10

APPENDIX L

SELECTED BORING LOGS FROM PREVIOUS INVESTIGATIONS



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CONSULTANTS, INC.

WELLS FROM PREVIOUS STUDIES

FIGURE L-1

(R-1)

Rinbrand Well Drilling

14 Waldron Avenue, Glen Rock, N. J.

LOG OF WELL

Log of Well for Scarabbi Construction Co Well No. 1

Address

Well located at Ramapo Ridge in West County, State of

Date Drilling Started Oct 2-1956 Date Completed

Total Depth to Bottom of Well Diameter of Well 10 x 6

Distance to Water from Surface feet inches Length of Casing 10" - 53 ft 6" - 69 ft

Distance to Water feet inches. When Pumping G. P. M.

Strata by (Stratum)	Depth of Strata	Formation Found in Each Stratum	Strata by (Stratum)	Depth of Strata	Formation Found in Each Stratu
0 to 12		Fill	161 to 280		Gray Granit
12 to 14		Bolders	280 to 365		Black & Gray Granit
14 to 49		Yellow clay small Bolders	365 to 390		White Granit
49 to 58		Bolders Broken Rock	39 to 410		Gray & White Gran
58 to 66		Rock Granit Gray			
66 to 84		Gray Granit Rock			
84 to 90		Fractured Granit Rock			
90 to 141		Gray Granit Rock			
141 to 147		Black Granit			
147 to 153		Gray Granit			
153 to 161		White Granit			

Remarks 100 ft 1/2 GPM 410 ft 11 GPM

200 ft 3 GPM

300 ft 5 GPM.

350 ft 7 GPM

Drilling Done by J. Rinbrand & Cliff Oct 13 Water Level 32 ft

N332 Oct 15 Water Level 34 ft 10" Drill No. 7109

Titan
DRILLING CORP. ARKVILLE N. Y. 12406 PHONE 914-586-4000

JUNE 11, 1986

MR. EUGENE OSTERTAG
TOWN OF RAMAPO HIGHWAY DEPT.
PIONEER AVE.
TALLMAN, N. Y. 10982

DEAR MR. OSTERTAG:

AS PER OUR TELEPHONE CONVERSATION, ENCLOSED FIND THE COPIES OF THE TEST WELLS DRILLED AT THE LANDFILL SITE, RAMAPO, NEW YORK. (PER YOUR REQUEST).

IF YOU HAVE ANY QUESTIONS, OR NEED MORE INFORMATION, CONTACT ME AT THE ABOVE NUMBER.

SINCERELY,

LYNN JOHNSON

PRESIDENT

LJ/dd

ENC.

1

TITAN DRILLING CORP.

TE[illegible]

DRILL LOG & WORK REPORT

FORM T

X-1

Sheet No. ____ of ____

Job

Rig No. ________

Location

DATE	FEET		WELL LOG	REPORT
	0	26	SAND & GRAVEL	
	26'		BED rock	

TAL DRILLING FT.

TOTAL GPM:

APPROX. BIT SIZE:

TAL CASING FT.

DRIVE SHOE:

OFFSET

CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

2 FORM T

X-2

Sheet No. ____ of ______

Job

Rig No. ______

Location

ATE	FEET		WELL LOG	REPORT
	0	10	Boulder	
	10	26	GRAVEL & Small rocks	
	26	30	Boulder	
	30		Bedrock	

OTAL DRILLING	FT.	TOTAL GPM:	APPROX. BIT SIZE:
OT‿L CASING	FT.	DRIVE SHOE:	OFFSET

R CONDITION:

DRILLER SIGNATURE

T 2 ?

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

FORM 7

Sheet No. ____ of ______

Job

Rig No. ______

Location

DATE	FEET		WELL LOG	REPORT
	0	8	SAND & GRAVEL	
	8	10	BoulDER	
	10	14	SAND & GRAVEL	
	14	16	BoulDER	
	16	27	SAND & GRAVEL	
	27		BeDrock	

OTAL DRILLING FT.	TOTAL GPM:	APPROX. BIT SIZE:
OTAL CASING FT.	DRIVE SHOE:	OFFSET

R CONDITION:

DRILLER SIGNATURE

#10

FORM

X-102

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Job

Rig No. __________

Location

DATE	FEET		WELL LOG	REPORT
	0	5	Fill	
	5	10	Boulders	
	10	15	Sand	
	15	20	GRAVEL	
	20		Bedrock	

TC AL DRILLING ____ FT.

TOTAL GPM:

APPROX. BIT SIZE:

TOTAL CASING ____ FT.

DRIVE SHOE:

OFFSET

ER CONDITION:

DRILLER SIGNATURE

103

FORM T

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

X-103

Sheet No. ____ of ______

Job

Rig No. ________

Location

ATE	FEET		WELL LOG	REPORT
	0	5	Sand Gravel	
	5	6	Boulder	
	6	10	Gravel	
	10	12	Boulder	
	12	20	Gravel	
	20		Bedrock	

TOTAL DRILLING FT. | TOTAL GPM: | APPROX. BIT SIZE:

OTAL CASING FT. | DRIVE SHOE: | OFFSET

WATER CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

FORM T

X-104

Sheet No. ____ of ______

Job

Rig No. ________

Location

TE	FEET		WELL LOG	REPORT
	0	2	SAND	
	2	8	Boulder	
	8	22	SAND, GRAVEL	
	22		BEDrock	

O L DRILLING	FT.	TOTAL GPM:	APPROX. BIT SIZE:
OTAL CASING	FT.	DRIVE SHOE:	OFFSET
R CONDITION:			DRILLER SIGNATURE

TITAN DRILLING CORP.

#105

FORM X-105

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Job

Rig No. ______

Location

DATE	FEET		WELL LOG	REPORT
	0	5	Sand & Gravel	
	5'	6	Boulder	
	6	14	Sand & Gravel	
	14	19	Boulder	
	19	21	Sand & Gravel	
	21		Bedrock	

TA DRILLING ____ FT.

TOTAL GPM:

APPROX. BIT SIZE:

AL CASING ____ FT.

DRIVE SHOE:

OFFSET

CONDITION:

DRILLER SIGNATURE

TT /

FORM T

X-106

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Job

Rig No. __________

Location

DATE	FEET		WELL LOG	REPORT
	0	3	Sand	
	3	5	Boulder	
	5	20	Sand	
	20	25	Gravel	
	25	30	Sand, Gravel	Lot of Water
	30		Bedrock	

TA DRILLING FT.	TOTAL GPM:	APPROX. BIT SIZE:
TAL CASING FT.	DRIVE SHOE:	OFFSET
CONDITION:		DRILLER SIGNATURE

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

#1 FORM X-107

Sheet No. ____ of ______

Job

Rig No. ________

Location

ATE	FEET		WELL LOG	REPORT
	0	5	Sand	
	5	7	Boulder	
	7	32	Sand Gravel	hit of Water
	32		Bedrock	

OT'L DRILLING FT.

TOTAL GPM:

APPROX. BIT SIZE:

OTAL CASING FT.

DRIVE SHOE:

OFFSET

R CONDITION:

DRILLER SIGNATURE

FORM TD

X-108

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Job

Rig No. ________

Location

TE	FEET		WELL LOG	REPORT
	0	10	Sand & Gravel	
	10	12	Boulder	
	12	21	Gravel	
	21'		Bedrock	

L DRILLING FT.

TOTAL GPM:

APPROX. BIT SIZE:

L CASING FT.

DRIVE SHOE:

OFFSET

ONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

X-109

FORM TD

Sheet No. ____ of ______

Job

Rig No. ________

Location

IA	FEET		WELL LOG	REPORT
	0	4	GRAVEL	
	4	6	Boulder	
	6	21	GRAVEL	
	21'		Bedrock	

TA DRILLING FT.	TOTAL GPM:	APPROX. BIT SIZE:
TAL CASING FT.	DRIVE SHOE:	OFFSET

CONDITION:

DRILLER SIGNATURE

110
FORM 1

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

x-110

Sheet No. ____ of ______

Job

Rig No. ______

Location

TE	FEET		WELL LOG	REPORT
	0	4	Sand & Gravel	
	4	9	Boulder	
	9	31	Sand & Gravel	lots of Water
	31	'	Bedrock	

DRILLING FT. TOTAL GPM: APPROX. BIT SIZE:

TAL CASING FT. DRIVE SHOE: OFFSET

CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

X-#111

FORM T

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Rig No. ______

Job

Location

DATE	FEET		WELL LOG	REPORT
	0	4	Sand	
	4	7	Boulder	
	7	18	Sand	
	18		Bedrock	

TA DRILLING FT: | TOTAL GPM: | APPROX. BIT SIZE:

TAL CASING FT: | DRIVE SHOE: | OFFSET

CONDITION:

DRILLER SIGNATURE

#112

TITAN DRILLING CORP.

FORM TD

DRILL LOG & WORK REPORT

X-112

Sheet No. ____ of ______

Rig No. ________

Job

Location

DA	FEET		WELL LOG	REPORT
	0	1	SAND	
	1	5	Boulder	
	5	6	SAND	
	6	8	Boulder	
	8	18	Bedrock	

AL DRILLING FT.	TOTAL GPM:	APPROX. BIT SIZE:
AL CASING FT.	DRIVE SHOE:	OFFSET

CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

FORM X-113

Sheet No. ____ of ______

Job

Rig No. ______

Location

DATE	FEET		WELL LOG	REPORT
	0	10	Sand & little Gravel	
	10	26'	Sand	
	26'		Bedrock	

TAL DRILLING FT.

TOTAL GPM:

APPROX. BIT SIZE:

TAL CASING FT.

DRIVE SHOE:

OFFSET

: CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

FORM T

DRILL LOG & WORK REPORT

Sheet No. ___ of ______

Job

Rig No. X-114

Location

ATE	FEET		WELL LOG	REPORT
	0	5	GRAVEL	
	5	10	Boulder	
	10	21	GRAVEL	
	21		Bedrock	

OTAL DRILLING FT. TOTAL GPM: APPROX. BIT SIZE:

OT.L CASING FT. DRIVE SHOE: OFFSET

R CONDITION:

DRILLER SIGNATURE

FU...

116

X

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

Rig No. —

Location

f

WELL LOG	REPORT
SAND & GRAVEL	
BOULDER	
GRAVEL	
BOULDER	
GRAVEL	
5 BEDROCK	
1	

APPROX. BIT SIZE:

OFFSET

FT. TOTAL GPM:

TA DRILLING FT. DRIVE SHOE:

TAL CASING

DRILLER SIGNATURE

CONDITION:

11 FORM TD

TITAN DRILLING CORP.

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Rig No. X-117

Job

Location

D TE	FEET		WELL LOG	REPORT
	0	3	SAND & GRAVEL	
	3	8	BOULDER	
	8	22	GRAVEL	
22	-3	2	BEDROCK	

OTAL DRILLING FT.

TOTAL GPM:

APPROX. BIT SIZE:

OTAL CASING FT.

DRIVE SHOE:

OFFSET

R CONDITION:

DRILLER SIGNATURE

TITAN DRILLING CORP.

#118 FORM

DRILL LOG & WORK REPORT

Sheet No. ____ of ______

Job

Rig No. X-118

Location

TE	FEET		WELL LOG	REPORT
	0	2	SAND	
	2	5	Boulder	
	5	11	SAND & GRAVEL	
	11		Bedrock	

TO L DRILLING ______ FT.

TOTAL GPM:

APPROX. BIT SIZE:

TOTAL CASING ______ FT.

DRIVE SHOE:

OFFSET

ER CONDITION:

DRILLER SIGNATURE

KENDRICK DRILLING, INC.
Test Borings & Diamond Drilling
10 Hawxhurst Road
Monroe, N.Y. 10950

914 783-3190

Boring No. B#1

PROJECT: RAMAPO LAND FILL

Location of Boring:

CLIENT: L JACKSON

Date, start 2/2/79 Finish 2/5/79

REMARKS:

Ground Water Observations

Date	Time	Depth	Casing at
2/2/79	4:00	18	14'

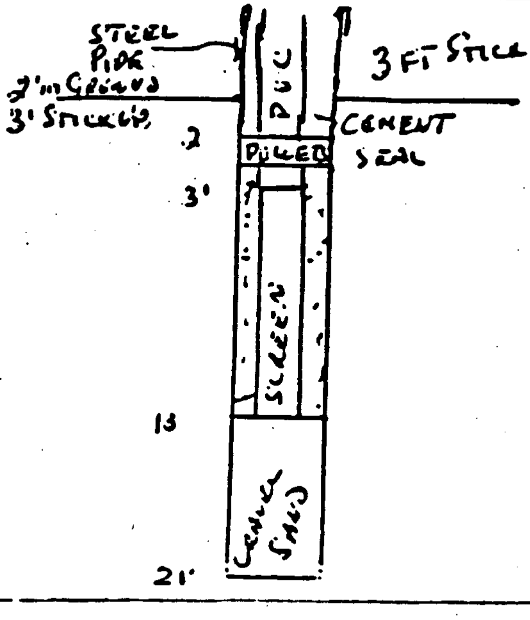
Casing Hammer
Wt. 350 lbs.
Fall in.

Sampler Hammer
Wt. 140 lbs.
Fall 36 in.
O.D. Spoon 2"
I.D. Casing 4"

Ground Elev.

Driller: KENDRICK Helper:

DEPTH BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
				BROWN SAND MICS FILL
5		1	11 19 23 31	BROWNISH-GRAY FINE TO MED SAND TRACE OF GRAVEL TR SILT TRACE VEGETATION.
10		2	52 94 102	GRAY FINE TO MED SAND SOME GRAVEL SOME BOULDERS WITH SILT. (TILL)
15		3	150/1"	BOULDERS OR ROCK
20		4	200/1"	



TOTAL 16' P.V.C
10 SCREEN
5' 4" CASING

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914 [illegible]

Boring No. #2

PROJECT: RAMAPO LAND FILL

Location of Boring:

LIENT: L. JACKSON 2 A

Date, start 2/3/79 Finish 2/5/79

MARKS:

Ground Water Observations

Date	Time	Depth	Casing at

Casing Hammer
: 330 lbs.
ll in.

Sampler Hammer
Wt. 140 lbs.
Fall 30" in.
O.D. Spoon 2"
I.D. Casing 4"

ound Elev.

Driller: T KENDRICK Helper:

GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	
5'		1	29	59
			45	49
c'		2	43	47
			61	72
5'		3	37	100/3"
c'		4	16E/6"	
87		5	200/6"	
c'		6	200/6"	
17		7	200/6"	
3'				

FIELD IDENTIFICATION OF SOIL & REMARKS

MIX'S SAND GRAVEL, WITH BLACK SILT FILL.

BROWN FINE SAND SOME COARSE SAND FINE GRAVEL LITTLE SILT

BROWN GRAY FINE SAND SOME COARSE SAND FINE GRAVEL TRACE SILT

BROWN FINE SAND WITH FINE GRAVEL LITTLE SILT

BROWN FINE SAND GRAVEL LITTLE SILT, FINE TO MED GRAVEL,

GRAY FINE SANDY SILT, SOME GRAVEL, BOULDERS, TILL MATERIAL.

PAGE 1

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Test Borings & Diamond Drilling
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Monroe, N.Y. 10950

914 783-3190

Boring No. BH2'

PROJECT: RAMAPO LAND FILL

Location of Boring:

CLIENT: L JACKSON

Date, start 2/3/79 Finish 2/5/79

REMARKS:

Ground Water Observations

Date	Time	Depth	Casing at
2/3/79		4'6"	

Casing Hammer
Wt. 350 lbs.
Fall in.

Sampler Hammer
Wt. 140 lbs.
Fall 30 in.
O.D. Spoon 2"
I.D. Casing 4"

Ground Elev.

Driller: T KENDRICK Helper:

DEPTH BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"
45'			
		8	100/0"
50'			
		9	100/0"
55'		10	200/3"
		11	130/1"

FIELD IDENTIFICATION OF SOIL & REMARKS

FROM 44' TO 50 VERY HARD

NOTE SAMPLE, LOOKS LIKE SOFT ROCK

BACK FILLED FROM 58 TO 50' WITH SAND & GRAVEL INSTALLED POINT FROM 50' TO 40' BACK FILLED WITH PEA GRAVEL TO 39', SEALED WITH BENTONITE PELLET TO 38" PUMPED GROUT TO SURFACE, MIXTURE CEMENT & BENTONITE POWDER, LEFT 2' OF 2" PLASTIC STICK UP, THEN CEMENTED 5' OF 4" CASING AROUND PLASTIC PIPE.

TOTAL 42' OF 2" PLASTIC PIPE.
10' WELL SCREEN.

LJ-2

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PROJECT: RAMAPO LAND FILL
CLIENT:
REMARKS:

Boring No. 2A
Location of Boring:
Date, start ____ Finish ____

Casing Hammer
Wt. ____ lbs.
Fall ____ in.

Sampler Hammer
Wt. 140 lbs.
Fall 36 in.
O.D. Spoon 2
I.D. Casing 4

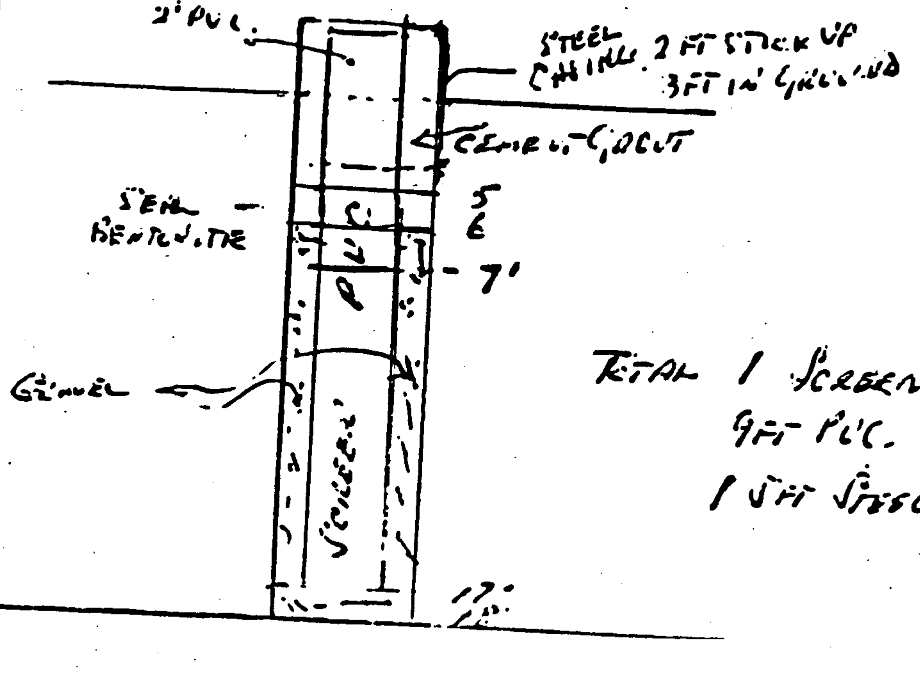
Ground Elev.

Ground Water Observations

Date	Time	Depth	Casing at

Driller: ____ Helper: ____

DEPTH BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
				MISC FILL
5				BROWN FINE SAND SOME COARSE SAND LITTLE SILT
10				BROWN GREY FINE SAND SOME COARSE SAND TRACE SILT BROWN FINE SAND WITH FINE GRAVEL
15				BROWN FINE SANDY SILT & SILTY SAND WITH FINE TO MED GRAVEL
20				



TOTAL 1 SCREEN
9 FT PVC
1 5 FT STEEL PIPE

LJ-3

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10 Hawxhurst Road
Monroe, N.Y. 10950

914 783-3190

Boring No. B# 3

PROJECT: RAMAPO LAND FILL

Location of Boring:

CLIENT:

REMARKS:

Date, start 3/5/79 Finish 3/6/79

Ground Water Observations

Date	Time	Depth	Casing at

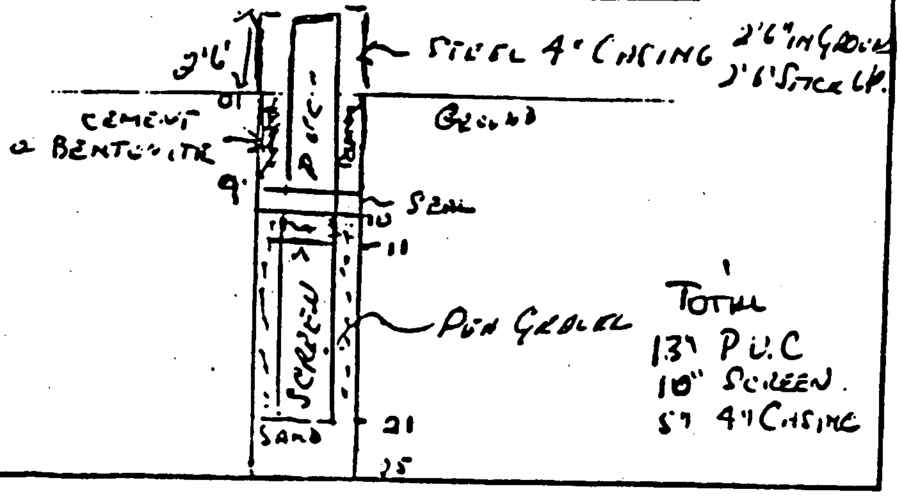
Casing Hammer
Wt. 350 lbs.
Fall in.

Sampler Hammer
Wt. 140 lbs.
Fall 30" in.
O.D. Spoon 2"
I.D. Casing 4"

Ground Elev.

Driller: KENDRICK Helper:

FT. BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
				MKIS FILL SAND BLACK SILT
5'		1	16 16	BROWN FINE SAND TR SILT TRACE FILL
			5 13	MED BROWN SAND TR SILT SILT
		2	11 10	
10'			10 11	FINE BROWN SAND TRACE GRAVEL SOME SILT SOME BOULDERS, (LOOSE) SLIGHT SMELL)
15'				
		3	9 - 10	
			12 - 10	
20'				
		4	16 19	
			39	
				BOULDERS OR ROCK.
25'				



TOTAL
13' PVC
10" SCREEN.
5' 4" CASING

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Boring No. 4

PROJECT: RAMAPO LAND FILL

Location of Boring:

CLIENT: L JACKSON

Date, start 3/3/79 Finish 3/3/79

REMARKS:

Ground Water Observations

Date	Time	Depth	Casing at

Casing Hammer
Wt. 350 lbs.
Fall in.

Sampler Hammer
Wt. 140 lbs.
Fall 36" in.
O.D. Spoon 2"
I.D. Casing 4'

Ground Elev.

Driller: Helper:

DEPTH BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
				BROWN SAND GRAVEL LARGE BOULDERS FILL SOME SILT
5			SEE B#4A	BROWN SAND SOME GRAY SAND GRAVEL SOME CLAY, BOULDERS
10			"	
15			"	
20				BROWN SAND GRAVEL TR SILT ROCK FRAG COBBLES
		4	33 - 27 31 - 34	
25				
		5	23 38 68	
30				
		6	30 · 72 43 54	
35				BOULDER
		7	28 79	BROWN SAND & GRAVEL TRACE SILT
				BOULDER
				BROWN SAND GRAVEL TR SILT BOULDERS, HARD DRILLING
40				

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LJ-4

914 783-3190

Boring No. 4

ROJECT: RAMAPO LAND FILL

Location of Boring:

CLIENT: L JACKSON

Date, start 3/3/79 Finish 3/3/79

EMARKS:

Ground Water Observations

Date	Time	Depth	Casing at

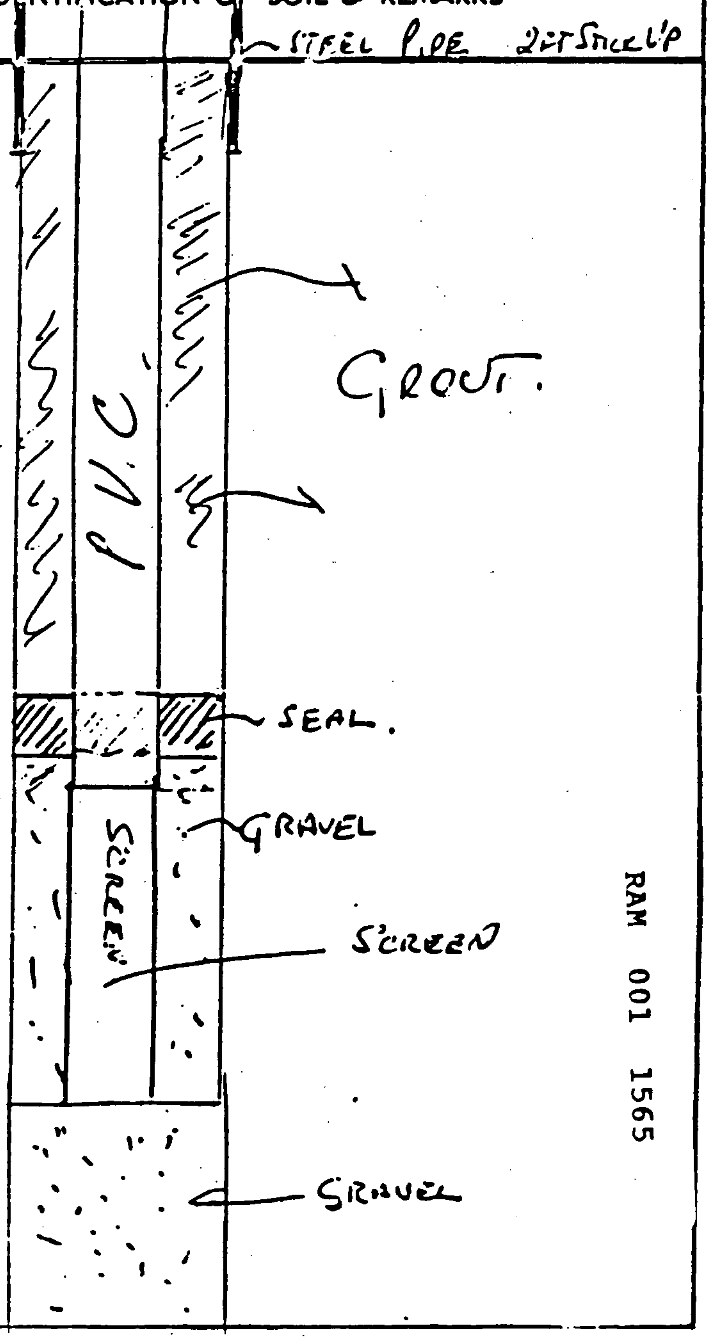
Casing Hammer
Vt. ______ lbs.
all ______ in.

Sampler Hammer
Wt. 140 lbs.
Fall 36" in.
O.D. Spoon 2"
I.D. Casing 4

round Elev.

Driller: L Kendrick Helper:

DEPTH BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
5				
10				
15				
20				
25				
30				TOTAL DEPTH. 42' SCREEN 10' PVC 23 STICK UP 2' 1 5FT STEEL PIPE
33				



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LJ-4A

Boring No. B# 4 A

ROJECT: RAMAPO LAND FILL.

Location of Boring:

LIENT: L. JACKSON

Date, start Finish

EMARKS:

Ground Water Observations

Date	Time	Depth	Casing at
	12 00.	6 ft.	

Casing Hammer
Vt. 350 lbs.
all in.

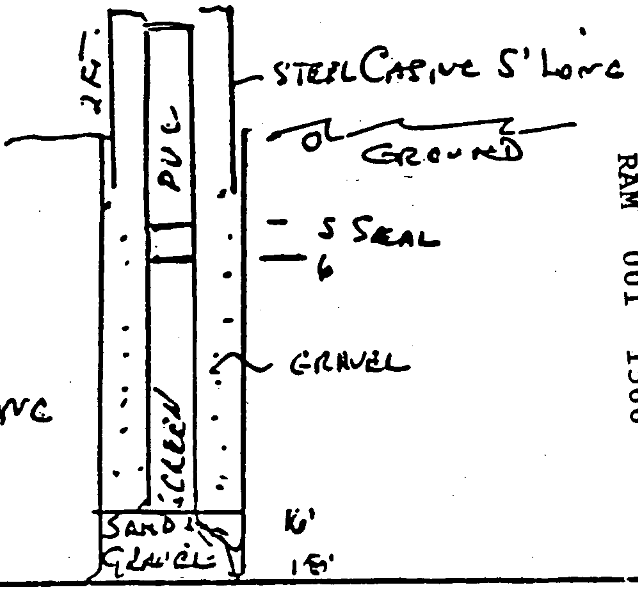
Sampler Hammer
Wt. 140 lbs.
Fall 36 in.
O.D. Spoon 2"
I.D. Casing 4"

round Elev.

Driller: Helper:

BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS
				BROWN SAND GRAVEL SOME SILT. & FILL. LARGE BOULDERS
5		1	10 - 11	BROWN SAND SOME GRAY SAND GRAVEL SOME CLAY, BOULDERS.
			12 14	
10		2		
			7 8	
			8 9	
15		3	150/1"	No Rec
				BOULDER OR ROCK
20'				

TOTAL 8' PVC
10 SCREEN
5 STEEL CASING



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Monroe, N.Y. 10950

914 783-3150

Boring No.

ROJECT: Ramapo Land Fill

Location of Boring:

LIENT: L JACKSON

Date, start Finish

EMARKS:

Ground Water Observations

Date	Time	Depth	Casing at

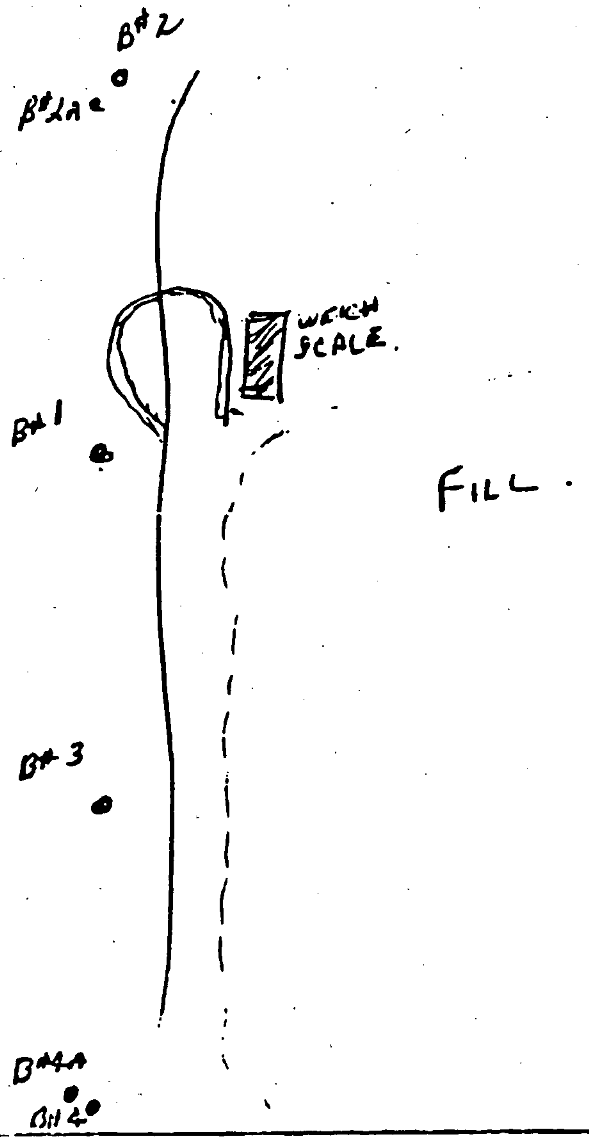
Casing Hammer
Wt. lbs.
Fall in.

Sampler Hammer
Wt. lbs.
Fall in.
O.D. Spoon
I.D. Casing

round Elev.

Driller: Helper:

DI BELOW GND. SURF.	CASING BLOWS PER FOOT	SAMPLE NO.	BLOWS ON SAMPLE SPOON PER 6"	FIELD IDENTIFICATION OF SOIL & REMARKS



MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

e 2/29/80 Job No 1 4201

dress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

d Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost Wat or Remark
	To					1st 6"	2nd 6"	3rd 6"		
	13'	Brown coarse to fine sand and gravel cobbles and boulders	SS	1	10	75/2			2"	
15'	23'	Brown fine to med. sand, some gravel cobbles	SS	2	20	12	18	14	13"	
	40'	Brown fine to coarse sand, some gravel, cobbles	SS	3	30	19	20	77	18"	
	48'	Brown coarse to fine sand, some gravel	SS	4	40	21	32	50/2	14"	
	51'	Brown coarse sand and gravel								
	52'	Hard bedrock								
		Grouted hole to 30'. Installed well at 29' sand, seal, grout standpipe OK								

Surface to ________ ft. used 22 ft casing. 10 ft. screen.

level is ________ ft. below Ground surface . ____ hrs. after completion. Foreman Earl Hauge

vel is ________ ft. below Ground surface . ____ hrs. after completion.

ng stopped by Bedrock Boring No. #5

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

2/28/80

Job No 1-4201

ddress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

d Surface this boring is

PTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost Wate or Remark
	To					1st 6"	2nd 6"	3rd 6"		
d.	16'	Brown coarse to fine sand and gravel cobbles, rock fragments	SS	1	10	26	50/1		6"	
1'	50'	Brown fine to medium sand, some gravel occassional cobbles	SS	2	20	17	10	16	18"	
0'	53'	Hard drilling, bedrock	SS	3	30	11	14	20	18'	
			SS	4	40	16	40		12"	

urface to ______ ft. used 43 ft casing. 10 ft. screen

l is ______ ft. below Ground surface. ______ hrs. after completion.

Foreman Earl Hauge

l is ______ ft. below Ground surface. ______ hrs. after completion.

stopped by Bedrock

Boring No. #5A

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

2/27/80

Job No 1 4201

ob Address RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

xed Datum used is G.S.

round Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in	Lost W o Rem
From	To					1st 6"	2nd 6"	3rd 6"		
Grd. urface	8'	Brown coarse to fine sand and gravel some cobbles								
8'	11'	Light brown coarse to fine sand, some gravel, occassional cobbles, 16' - 19' boulder	SS	1	11	38	50/1"		6"	
28	33	Bedrock	SS	2	20'				1"	

ound Surface to ______ ft. used 22 ft casing 10 ft. screen

ater level is ______ ft. below Ground surface ____ hrs. after completion.

ater level is ______ ft. below Ground surface ____ hrs. after completion.

oring stopped by Bedrock

Foreman Earl Hauge

Boring No. #6

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

5/4/80

Job No 1-4201

ddress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

LJ-7

e Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost Wa or Remar
n	To					1st 6"	2nd 6"	3rd 6"		
	12'	Brown coarse to fine sand and gravel boullders and cobbles	SS	1	10	29	50/1		6"	
1 '	23'	Light brown fine to med. sand, some gravel, boulders and cobbles	SS	2	20	17	31	37	18"	
'	42'	Gray brown med to fine sand. Little gravel, trace silt, occasional bould	SS	3	30	17	50/1		6"	
'	44'	Hard drilling, bedrock	SS	4	40	86			6"	

Surface to ________ ft. used 32 ft casing. 10 ft. screen

level is ________ ft. below Ground surface ________ hrs. after completion.

Foreman Earl Hauge

vel is ________ ft. below Ground surface ________ hrs. after completion.

stopped by Bedrock

Boring No. #7

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

27. 80

Job No 1-4201

lress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

Surface this boring is

DEPTH To	CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon 1st 6"	2nd 6"	3rd 6"	Recovery in.	Lost Water or Remarks
23'	Cobbles in medium to fine sand and gravel	SS	1	10	50/1				
40	Brown gray coarse to fine sand some gravel, cobbles	SS	2	20	62			6"	
52	Cobbles, boulders, large gravel in coarse sand	SS	3	30	37	39	50	18"	
55	Hard drilling, bedrock	SS	4	40	68			6"	
	Installed wellpoint at 42'								

face to ft. used 35 ft casing. 10 ft screen

is ft. below Ground surface hrs. after completion.

is ft. below Ground surface hrs. after completion.

Foreman Earl Hauge

ped by Bedrock

Boring No #8

MORETRENCH AMERICAN CORP.

4/80

RECORD OF SOIL EXPLORATION

Job No 1-4201

ddress RAMAPO SANITARY LANDFILL

ed Datum used is GS

ound Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No. of 30" blows on Spoon			Recovery in.	Lo F
rom	To					1st 6"	2nd 6"	3rd 6"		
Grd. Surface	22	Cobbles and boulders in medium to fine sand and gravel								
22	28	Brown gray coarse to fine sand and some gravel, cobbles								
		Installed wellpoint at 25 sand, seal grout, st. pipe OK								

Surface to ______ft. used 17 ft casing. 10 ft screen

level is ft. below Ground surface hrs after completion. Foreman Earl Hauge

vel is ft. below Ground surface hrs after completion.

stopped by

Boring No #8A

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

Job No 1-4201

ress. RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost W. or Rema
n	To					1st 6"	2nd 6"	3rd 6"		
face	14'	Boulders and cobbles in coarse to fine sand and gravel								
1'	16'	Hard drilling, bedrock, no samples								
		Installed wellpoint at 15'. Sand, seal, grout, standpipe OK								

Surface to ______ ft. used 8 ft. casing. 10 ft. screen.

level is ______ ft. below Ground surface ______ hrs. after completion. Foreman Earl Hauge

el is ______ ft. below Ground surface ______ hrs. after completion.

stopped by Bedrock Boring No. #9

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

7/80

Job No 1-4201

dress. RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

l Surface this boring is

PTH To	CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon 1st 6"	2nd 6"	3rd 6"	Recovery in.	Lost Wate or Remarks
15	Cobbles and boulders in coarse to fine sand and gravel	SS	1	10	45				
38	Gray coarse to medium sand some gravel, cobbles	SS	2	20	31	42	55	18	
47	Cobbles and boulders and gravel in coarse sand	SS	3	30	24	35	40	18	
50	Hard drilling, bedrock	SS	4	40	50/1				
	Installed well at 40'								

urface to ______ ft. used 33 ft casing. 10 ft screen

el is ___ ft. below Ground surface ___ hrs. after completion.

Foreman Earl Hauge

el is ___ ft. below Ground surface ___ hrs. after completion.

opped by Bedrock

Boring No. #10

MORETRENCH AMERICAN CORP.

4/7/80 RECORD OF SOIL EXPLORATION Job No 1 4201

dress RAMAPO SANITARY LANDFILL

d Datum used is GS

nd Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost Re
m	To					1st 6"	2nd 6"	3rd 6"		
[illegible]	15	Cobbles and boulders in coarse to fine sand and gravel								
5	28	Gray coarse to medium sand some gravel								
		Installed wellpoint at 26', sand, seal, grout, st. pipe OK								

d Surface to ft. used 18 ft. casing. 10 ft. screen

evel is ft. below Ground surface. hrs. after completion. Foreman Earl Hauge

evel is ft. below Ground surface hrs. after completion.

stopped by Boring No. #10A

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

17/80 Job No 1-4201

ddress RAMAPO LANDFILL, RAMAPO, N.Y.

Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost Wate or Remark
	To					1st 6"	2nd 6"	3rd 6"		
	7'	Brown coarse to find sand and gravel cobbles								
	12'	Boulder								
	19'	Cobbles and boulders in coarse to fine sand and gravel								
	22'	Hard drilling, bedrock								
		No samples, no wellpoint								

Surface to ______ ft. used ______" casing.

evel is ______ ft. below Ground surface ______ hrs. after completion.

el is ______ ft. below Ground surface ______ hrs. after completion.

stopped by Bedrock

Foreman Earl Hauge

Boring No. #11

80

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

Job No 1 4201

dress. RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

LJ-11A

Surface this boring is

PTH	CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost Wat or Remark
To					1st 6"	2nd 6"	3rd 6"		
21	Cobbles and boulders in coarse to fine sand and gravel								
24	Hard drilling, bedrock								
	No samples								
	Installed wellpoint at 21'								

face to ______ ft. used 13 ft casing. 10 ft screen

l is ______ ft. below Ground surface ______ hrs. after completion. Foreman Earl Hauge

is ______ ft. below Ground surface ______ hrs. after completion.

ped by Bedrock

Boring No. #11A

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

3/6/80

Job No [illegible]

ddress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

d Surface this boring is

EPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No. of 30" blows on Spoon			Recovery in.	Lost Wate or Remark
	To					1st 6"	2nd 6"	3rd 6"		
	17'	Large boulders and cobbles in coarse to fine sand and gravel								
	22'	Hard drilling, bedrock, no samples								
		Installed wellpoint at 20', sand seal grout, standpipe OK								

Surface to ____ ft. used 12 ft casing. 10 ft. screen

evel is ____ ft. below Ground surface ____ hrs. after completion.

Foreman Earl Hauge

vel is ____ ft. below Ground surface. ____ hrs. after completion.

stopped by Bedrock

Boring No. #12

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

5/11/80 Job No 1-4201

ress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

atum used is GS

Surface this boring is

PTH	CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost Water or Remarks
To					1st 6"	2nd 6"	3rd 6"		
25'	Boulders and cobbles in coarse to fine sand and gravel	SS	1	10'	50/1			6"	
28'	Hard drilling, bedrock	SS	2	20	38	50/1		6"	

face to ft. used 17 ft casing. 10 ft. screen.

l is ft. below Ground surface hrs after completion. Foreman Earl Hauge

is ft. below Ground surface hrs. after completion.

ped by Bedrock Boring No. #13

MORETRENCH AMERICAN CORP.

5/20/80 RECORD OF SOIL EXPLORATION Job No. 1-4201

Address RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

LJ-14

ed Datum used is GS

und Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost Ren
rom	To					1st 6"	2nd 6"	3rd 6"		
d. surface	20	Cobbles and boulders in coarse to fine sand and gravel	SS	1	10	31	75		16"	
20	40	Hard drilling, bedrock								
		Installed wellpoint at 21'								

nd Surface to ______ ft. used 13 ft casing. 10 ft screen

r level is ______ ft. below Ground surface ______ hrs. after completion. Foreman Earl Hauge

level is ______ ft. below Ground surface ______ hrs. after completion.

g stopped by Bedrock Boring No. #14

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

/80 Job No 1 4201

ddress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

Datum used is GS

d Surface this boring is

EPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost We or Remar
	To					1st 6"	2nd 6"	3rd 6"		
face	18'	Cobbles and boulders in coarse to fine sand and gravel	SS	1	10	40	50/1		6"	
'	25'	Hard drilling, bedrock								
		Installed wellpoint at 21'								

Surface to ______ ft. used 13 ft casing. 10 ft screen

evel is ______ ft. below Ground surface ______ hrs. after completion. Foreman Earl Hauge

vel is ______ ft. below Ground surface ______ hrs. after completion.

stopped by Bedrock Boring No. #15

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

5/19/80

Job No 1-4201

ddress RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

d Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost W or Rem
n	To					1st 6"	2nd 6"	3rd 6"		
1. ace	21'	Cobbles and boulders in coarse to fine sand and gravel	SS	1	10	31	50		12"	
1'	28'	Gray brown medium to fine sand some gravel	SS	2	20	27	50/1		6"	
8'	32'	Hard drilling, bedrock								
		Installed wellpoint at 28'								

Surface to ______ ft. used 20 ft casing. 10 ft. screen

vel is ______ ft. below Ground surface ______ hrs. after completion. Foreman Earl Hauge

vel is ______ ft. below Ground surface ______ hrs. after completion.

topped by Bedrock

Boring No. #16

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

Job No 1-4201

Address. RAMAPO SANITARY LANDFILL, RAMAPO, N.Y.

ed Datum used is GS

und Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Lost V o Rem
um	To					1st 6"	2nd 6"	3rd 6"		
d. face	12	Cobbles and boulders in coarse to fine sand and gravel	SS	1	10	50/1				
2	28	Coarse gray brown sand	SS	2	20	17	28	40	18	
8	49	Fine to medium gray sand some gravel trace silt, cobbles	SS	3	30	75			6	
9	52	Hard drilling bedrock	SS	4	40	31	60		12	
		Installed wellpoint at 40'								

rface to ______ ft. used 32 ft casing. 10 ft screen

is ______ ft. below Ground surface ______ hrs. after completion.

is ______ ft. below Ground surface ______ hrs. after completion.

ped by Bedrock

Foreman Earl Hauge

Boring No #17

MORETRENCH AMERICAN CORP.

1, 1, 80

RECORD OF SOIL EXPLORATION

Job No 1 [illegible]

RAMAPO SANITARY LANDFILL

Address

d Datum used is GS

und Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.	Depth	No of 30" blows on Spoon			Recovery in.	Los R
om	To					1st 6"	2nd 6"	3rd 6"		
rd. Surface	13	Brown medium to coarse sand some gravel cobbles	SS	1	10	14	20	27	18	
13	28	Brown fine to coarse sand trace gravel	SS	2	20	20	17	30	18	
28	33	Cobbles, gravel and boulders	SS	3	30	50/1				
33	36	Hard drilling, bedrock								
		Installed wellpoint at 32'								

d Surface to ft. used 24 ft casing. 10 ft screen

ter level is ft. below Ground surface. hrs. after completion.

level is ft. below Ground surface hrs. after completion.

Foreman Earl Hauge

ng stopped by Bedrock

Boring No. #18

MORETRENCH AMERICAN CORP.

4/2, 80

RECORD OF SOIL EXPLORATION

Job No 1-[illegible]

gdress. RAMAPO SANITARY LANDFILL

d Datum used is GS

d Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No of 30" blows on Spoon			Recovery in.	Lost We or Remar
	To					1st 6"	2nd 6"	3rd 6"		
[illegible]	16	Cobbles and boulders in coarse to fine sand and gravel								
16	20	Hard drilling								
		No samples								
		Installed wellpoint at 17', sand, seal grout, st. pipe OK								

Surface to. ft. used. 9 ft. casing. 10 ft. screen

level is . ft. below Ground surface. hrs. after completion. Foreman Earl Hauge

el is . ft. below Ground surface . hrs. after completion.

stopped by Bedrock Boring No. #20

MORETRENCH AMERICAN CORP.

RECORD OF SOIL EXPLORATION

/5/80

Job No. 1-[illegible]

Address RAMAPO SANITARY LANDFILL

LJ-21

d Datum used is GS

nd Surface this boring is

DEPTH		CLASSIFICATION Be Careful and Accurate	Sample Type	Sample No.*	Depth	No. of 30" blows on Spoon			Recovery in.	Lost Re
m	To					1st 6"	2nd 6"	3rd 6"		
Grd. Surface	12	Tan fine to medium sand, trace clay and gravel, occasional cobbles	SS	1	10	11	17	20	18	
12	26	Brown coarse to fine sand, little gravel, occasional cobbles	SS	2	20	19	23	27	18	
26	30	Hard drilling, bedrock								
		Installed wellpoint at 26', sand seal, grout st. pipe OK.								

d Surface to ______ ft. used 18 ft. casing. 10 ft. screen

level is ______ ft. below Ground surface. ______ hrs. after completion.

level is ______ ft. below Ground surface ______ hrs. after completion.

stopped by Bedrock

Foreman Earl Hauge

Boring No. #21

APPENDIX M

ANALYTICAL RESULTS FROM PREVIOUS INVESTIGATIONS

Table 1-1 from the Remedial Investigation, which is re-presented here, summarizes efforts performed prior to the RI. Data report numbers shown on this table correspond to the laboratory data sheets and summary tables of analytical data from previous investigations at or in the vicinity of the Ramapo Landfill. This information was taken from reports and information in the NYSDEC, NYSDOH, and Town of Ramapo files. Note that not all results could be located (i.e. #1,2,19), or were too voluminious to reproduce (i.e. #28,29).

SUMMARY OF PREVIOUS INVESTIGATIONS

PG 1 of 4

Data Report Numbers	Date	Matrix	Activity
#1	1974	Leachate	Water company discovered a black sludge emanating from landfill
#2	May 31, 1974	Surface Water (Torne Brook)	Weekly sampling of Torne Brook at 3 locations initiated by Spring Valley Water Supply Co.
#3	June 26, 1974	Leachate	Passaic Valley Water Commission analyzed discharge to Torne Brook
#4	June 1974 to October 1978	Leachate and Surface Water (Torne Brook and Ramapo River)	NYSDOH and NJDOH analyzed samples taken of leachate, Torne Brook and Ramapo River (6/18/74; 11/24/76; 10/20/77; 2/13/78; 6/29/78; 8/15 & 16/78; 10/30 & 31/78)
#5	September 11, 1975	Surface Water (Ramapo River)	Town of Ramapo sampled upstream, opposite and downstream of site
#6	October 17, 1975	Leachate	Hackensack Water Co. analysis of leachate
#7	1975	Leachate and Surface Water (Ramapo River)	Hackensack Water Co. analyzed leachate and upstream, opposite and downstream of site in Ramapo River
#8	March 9, 1976	Surface Water (Torne Brook and Ramapo River)	Rockland County Department of Health sampled Torne Brook upstream of site and 1,000 ft. from confluence with River; sampled River upstream and downstream of Torne Brook
#9	August 26, 1976	Groundwater	NYSDOH sample at weigh station
#10	November 24, 1976	Surface Water (Torne Brook)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) samples taken 50 ft below holding pond outlet and 10 ft below confluence of leachate and Torne Brook

PG 2 of 4

Data Report Numbers	Date	Matrix	Activity
#11	May 1978	Surface Water (Torne Brook and Ramapo River)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) sampled Torne Brook at 8 locations, Ramapo River at 3 locations and analyzed for only specific conductance
#12	June 21 and July 11, 1978	Surface Water (Ramapo River)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) sample taken both dates from Ramapo River 1350 ft. downstream from mouth of Brook
#13	September 6, 1978	Leachate	Unknown laboratory analysis of leachate
#14	March 21, 1979	Groundwater	NYSDOH sampled wells 1, 2A, 3, 4A
#15	March 21, 1979	Groundwater	Unknown lab analyzed wells 1, 2, 2A, 3, 4, 4A
#16	March 21, 1979	Groundwater	Hackensack Water Co. analyzed wells 1, 2, 2A, 3, 4, 4A
#17	March 21, 1979	Groundwater	Fred C. Hart Assoc. sampled B-129 through B-136
#18	April 1 and 11, 1980	Groundwater	Leonard Jackson Assoc. analyzed the majority of the 25 monitoring wells for specific conductance
#19	May 29, 1980	Air	EPA Region II Field Investigation Team explosimeter survey
#32	July, 1980	Offsite Soil and Drum Contents	RCHD collected soil and liquid drum contents from Ramapo Landfill Co. property
#20	October 11, 1980	Waste	EPA sampled a sludge-like material from an unknown location on or near landfill
#21	October 11, 1980	Leachate	EPA sampled at the leachate inflow and outflow

Data Report Numbers

PG 3 of 4

	Date	Matrix	Activity
#22	February and March, 1981	Groundwater	NYSDEC performed extensive sampling and analysis of monitoring wells (2/4/81; 2/18/81; 3/11/81)
#23	March 11, 1981	Groundwater	Hackensack Water Co. analyzed samples from monitoring wells 3, 5, 5A, 8A, 18
#24	1982	Surface water (Torne Brook at confluence with Ramapo River)	NYSDOH analyzed samples taken by NYSDEC for the program: Routine Toxics Surveillance Network Near Problem Landfills (6/1/82; 6/29/82; 7/27/82; 8/24/82; 9/20/82; 10/19/82)
#25	Late 1982 and March 15, 1983	Leachate, Groundwater	NYTL analyzed 2 leachate and 2 groundwater samples
#26	October 28, 1983	Waste	Sample obtained during the course of excavating trench
#27	1983	Leachate	Analysis for NPDES permit
#28	1984 - 1985	Leachate	Town of Ramapo sampled leachate monthly in collectors
#29	1986 - Present	Leachate	Weekly analysis of leachate by Envirotest Laboratories, Inc. for the Town of Ramapo
#33	February 5, 1987	Groundwater, surface water, sediments	NUS Corp. collected samples during their investigation on Ramapo Land Co. property
#30	March 16, 1988	Groundwater	All wells analyzed for indicator parameters; 3 wells in depth analysis for Town of Ramapo
#31	July 25, 1988	Groundwater	Dunn Geoscience sampled monitoring well DGC-6S which was installed at the proposed Torne Valley Balefill site, north of the Ramapo Landfill

TABLE 4-13

SURFACE WATER ANALYSIS
RAMAPO LANDFILL SITE

	Downstream	Opposite Landfill	Upstream	Downstream	Opposite Landfill	Upstream	Leachate	Torne Brook Upstream	Torne Brook 1000-ft Upstream to Ramapo River	Ramapo River 100-ft Upstream of Torne Brook	Ramapo River 2000-ft Downstream of Torne Brook
Sampled by: Parameter	9/11/75 Town of Ramapo	9/11/75 Town of Ramapo	9/11/75 Town of Ramapo	1975 Hackensack Water	1975 Hackensack Water	1975 Hackensack Water	1975 Hackensack Water	3/9/76 Rockland County	3/9/76 Rockland County	3/9/76 Rockland County	3/9/76 Rockland County
pH (Units)	7.8	8.0	7.8	-	-	-	-	-	-	-	-
Dissolved Oxygen	5.2	4.4	5.4	9.9	10.2	10.9	0	-	-	-	-
BOD	14	15.6	9	1.6	3.7	1.5	GT270	-	-	-	-
Suspended Solids	8	10	5	-	-	-	-	-	-	-	-
Coliform, MPN	-	-	-	6,213	5,701	1,003	940	73	1,200	230	430
Fecal Coliform, (MPN/100ml)	-	-	-	-	-	-	-	LT 36	91	230	91

All results given in PPM except as noted.
GT Greater Than
LT Less Than
- Indicates not analyzed for.

#5,7,8
PG 1 of 1

TABLE 4-2

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
WELL SAMPLES - NEW YORK STATE DEPARTMENT OF HEALTH

Parameter	Weigh Station 8/26/76	1 3/21/79	2A 3/21/79	3 3/21/79	4A 3/21/79
Color (Units)	3	-	-	-	-
Nitrogen, NH_3	LT 0.005	-	-	-	-
Nitrogen, NO_2(µg/l)	5.01	-	-	-	-
Nitrogen, $NO_3 + NO_2$	0.102	-	-	-	-
Chloride	38.3	-	-	-	-
Hardness, Total	138	-	-	-	-
Alkalinity, Methylorange	115	-	-	-	-
pH (Units)	7.6	-	-	-	-
COD	4	-	-	-	-
Iron	-	48	36	200	27
Manganese	-	6.0	0.9	23	6.5
Sodium	6.4	-	-	-	-
Turbidity	0.55	-	-	-	-
Phenols	-	0.003	0.005	0.70	-
TOC	-	34	5.0	98	-
Arsenic	-	0.02	0.05	0.04	0.03
Cadmium	-	LT 0.02	LT 0.02	LT 0.02	LT 0.02
Chromium, Total	-	LT 0.1	LT 0.1	LT 0.1	LT 0.1
Lead	-	LT 0.1	LT 0.1	LT 0.1	LT 0.1
Mercury	-	LT 0.0004	LT 0.0004	LT 0.0004	LT 0.0004
Selenium	-	LT 0.01	LT 0.01	LT 0.01	LT 0.01
Xylene (µg/l)	-	-	-	GT 800	-
Toluene (µg/l)	-	-	-	GT 50	-
Benzene (µg/l)	-	-	-	-	GT 200

Pg 1 of 1
#9,14

Note: Results given in mg/l unless noted
LT: Less than
GT: Greater Than
- : Dashes indicate that the compounds were not analyzed for.

TABLE 4-4

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
TEST BORINGS - 3/21/79

Parameter	Boring Number 1	2	2A	3	4	4A
pH	6.7	7.2	7.6	6.5	5.9	6.4
Chloride	82	90	243	207	9	25
Ammonia, free (N)	0.03	0.07	0.12	0.32	0.02	0.19
Nitrite (N)	0.05	0.01	0.09	0.03	0.01	0.02
Nitrate (N)	0.35	0.51	0.27	0.33	0.23	0.10
Fluoride	0.09	0.11	0.07	0.07	0.05	0.10
COD	197	119	88	2,856	142	48
BOD - 5 day	75	21	12	474	21	9
Total Coliforms (No./100 ml)	700	2,400	240	500	7,000	LT 23
Aluminum	0.42	0.12	0.63	20.0	0.03	1.05
Copper	0.10	1.01	0.10	0.05	0.09	0.05
Iron (Total)	39.0	3.4	31.4	46.6	0.52	29.5
Manganese	0.74	2.30	0.16	0.66	4.00	1.05
Selenium	0.0001	0.0001	0.0001	0.0001	LT 0.0001	LT 0.0001
Silver	0.0050	0.0050	0.0080	0.0140	0.0070	0.0050
Zinc	0.18	0.07	0.25	0.10	0.06	0.08
Arsenic	0.0050	0.0003	0.0045	0.0084	0.0001	0.0020
Barium	0.285	0.044	0.286	0.307	0.032	0.052
Cadmium	0.0005	0.0002	0.0012	0.0006	0.0005	0.0003
Chromium	0.0256	0.0025	0.0291	0.0115	0.0009	0.0076
Lead	0.022	0.007	0.059	0.011	0.003	0.011
Mercury	0.0005	0.0001	0.0001	0.0003	0.0002	0.0001
Volatile Halogenated Organics	ND	ND	ND	ND	ND	ND

Pg 1 of 1
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Volatile Halogenated Organics include: Methylene Chloride, Chloroform, 1,2-Dichloroethane, 1,1,1-Trichloroethane, Carbon Tetrachloride, 1,1,2-Trichloroethylene, Dichlorobromomethane, 1,2-Dibromoethane, Tetrachloroethylene, Bromoform, 1,1,2,2-Tetrachloroethane, Diiodomethane, Dibromochloromethane, 1,1,2-Trichloroethane, Dichlorobenzene, Mixed Isomers.

ND: Non Detectable

LT: Less Than

All results are given in mg/l

Analysis performed by the Hackensack Water Company.

TABLE 4-14

SURFACE WATER ANALYSIS
RAMAPO LANDFILL SITE

Parameter	Torne Brook 50 ft below Holding Pond Outlet 11/24/76	Torne Brook 10 ft below confluence of leachate and brook 11/24/76	Ramapo River, 1350 ft downstream from mouth of Torne Brook	
			6/21/78	- 7/11/78
Arsenic	-	-	0.001	0.001
Barium	1.0	-	0.09	0.12
Cadmium	0.02	-	0.001	0.004
Chromium (hexavalent)	0.1 (total)	-	LT 0.005	0.006
Copper	0.05	-	0.07	0.01
Iron	0.3	0.48	0.26	0.27
Lead	0.1	-	0.017	0.017
Manganese	-	-	0.02	0.05
Mercury	0.0004	-	LT 0.0001	0.0007
Selenium	-	-	LT 0.001	LT 0.001
Silver	-	-	0.004	0.001
Zinc	0.05	0.05	0.08	0.02

All results are given in ppm
LT: Less Than
Analysis performed by Leggette, Brashears & Graham, Inc.
- : Indicates not analyzed for.

#10, 12
PG 1 of 1

TABLE 4-15

SURFACE WATER ANALYSIS
RAMAPO LANDFILL SITE

Location	Sample Date	Specific Conductance
Torne Brook, at new bridge on entrance road into O&R substation, approximately 0.8 mile north of Holding Pond.	5/25/78 5/31/78	39 44
Torne Brook tributary above landfill, approximately 0.7 mile along access road north of Holding Pond.	5/25/78	49
Torne Brook, at bridge approximately 500 ft south along access road from weigh station.	5/25/78 5/31/78	54 65
Torne Brook, approximately 75 ft upstream from mouth of outflow from Holding Pond.	5/31/78	74
Torne Brook, approximately 100 ft downstream from mouth of outlet of Holding Pond.	5/31/78	152
Torne Brook, aproximately 150 ft downstream from mouth of outlet of Holding Pond.	5/25/78	90

Pg 1 of 2
#11

TABLE 4-15
SURFACE WATER ANALYSIS
RAMAPO LANDFILL SITE
PAGE TWO

Location	Sample Date	Specific Conductance
Outlet of Holding Pond, at culvert under access road.	5/25/78 5/31/78	840 1490
Culvert outlet under access road opposite old equipment yard and approximately 450 ft south of outlet of Holding Pond.	5/25/78 5/31/78	59 57
Ramapo River, approximately 800 ft upstream from entrance of Torne Brook at edge of Old slag dump.	5/31/78	171
East side of Ramapo River, approximately 100 ft downstream from mouth of Torne Brook.	5/25/78	129
East side of Ramapo River, at picnic area on galciated bedrock shore, approximately 0.3 mile south of Holding Pond.	5/31/78	178

#11
Pg 297

Results are given in µmho/cm

Analysis performed by Leggette, Brashears, and Graham, Inc.

TABLE 4-3

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
WELL SURVEY AT ROCKLAND COUNTY LANDFILL - 3/21/79

Unknown Lab (see p. 4-3)

Parameter	Well Number					
	1	2	2A	3	4	4A
Mercury	LT 0.001	LT 0.001	0.001	0.001	0.004	0.311
Total Chromium	0.35	LT 0.02	0.02	0.31	LT 0.02	0.02
Manganese, S	6.9	2.0	1.1	30.6	3.1	7.9
Arsenic	0.071	0.023	0.047	0.046	0.015	0.035
Cadmium	0.02	0.04	0.04	0.05	0.02	0.06
Zinc	0.63	0.29	0.44	0.35	0.21	0.29
Silver	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05
Iron	68.0	6.3	39.8	69.6	1.0	42.5
Nickel	0.24	0.19	0.14	0.27	0.10	0.23
Lead	0.033	0.005	0.020	0.004	LT 0.002	LT 0.002
Copper	0.13	LT 0.02	0.04	0.03	LT 0.02	0.03
Aluminum, T	119.6	1.8	24.9	1.8	LT 0.50	7.9
TSS	5,209.6	129.6	6,976.4	636.4	16.0	391.6
Settleable Solids	6,196	188	6,906	597	LT 1	603
BOD	61	50	5	1923	17	7
pH	6.6	6.9	7.2	6.3	5.7	6.3
Nitrate	0.5	LT 0.1	0.3	0.5	0.1	0.4

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Pg 1 of 3

TABLE 4-3

GROUNDWATER ANALYSIS

RAMAPO LANDFILL SITE

WELL SURVEY AT ROCKLAND COUNTY LANDFILL - 3/21/79

PAGE TWO

Parameter	Well Number					
	1	2	2A	3	4	4A
Phenols	0.003	0.005	0.033	0.560	0.004	0.010
Ammonia	0.49	0.34	0.69	0.80	0.24	0.99
Hexavalent Chromium	0.03	LT 0.01	LT 0.01	LT 0.01	LT 0.01	LT 0.01
Chloride	84.7	103.8	232.5	207.2	5.4	63.1
Fluoride	0.19	0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05
Sulfate	17.8	18.6	31.6	LT 1	15.3	10.9
COD	160.0	89.1	29.7	244.1	51.8	39.4
Cyanide	0.070	LT 0.001	LT 0.001	0.10	LT 0.001	LT 0.001
Barium	LT 0.10	LT 0.10	LT 0.10	LT 0.10	LT 0.10	LT 0.10
Selenium	0.082	0.012	0.035	0.790	0.100	LT 0.001
Total Coliforms, MPN	GT 2400	GT 2400	240	LT 2	GT 2400	920
Fecal Coliforms, MPN	GT 16 for 5-ten ml tubes	GT 16 for 5-ten ml tubes	GT 16 for 5-ten ml tubes	All presumptive tubes were negative. No fecal tests were conducted	GT 16 for 5-ten ml tubes	9.2 for 5-ten ml tubes

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PG 2 of 3

TABLE 4-3

GROUNDWATER ANALYSIS

RAMAPO LANDFILL SITE

WELL SURVEY AT ROCKLAND COUNTY LANDFILL - 3/21/79

PAGE THREE

Parameter	Well Number					
	1	2	2A	3	4	4A
Cyanide	LT 0.005	LT 0.005	LT 0.005	LT 0.005	LT 0.005	LT 0.005
PCB*	LT 0.5	LT 0.5	LT 0.5	LT 0.5	LT 0.5	LT 0.5
Chloroform*	LT 1	LT 1	9	4	LT 1	LT 1
1,1,2-trichloro-1,2,2-trifluorethane*	LT 1	LT 1	LT 1	LT 1	LT 1	LT 1
1,1,1-trichlorethane*	LT 1	LT 1	LT 1	3	LT 1	LT 1
Carbon tetrachloride*	LT 1	LT 1	LT 1	LT 1	LT 1	LT 1
Bromodichloromethane*	LT 1	LT 1	3	LT 1	LT 1	LT 1
Trichloroethylene*	LT 1	LT 1	LT 1	1	LT 1	LT 1
Tetrachloroethylene*	LT 1	LT 1	LT 1	1	LT 1	LT 1

All results are given in mg/l unless otherwise noted
* : This result is given in µg/l
LT: Less Than
GT: Greater Than
Analysis performed by an unknown laboratory.

#15
PG 3 of 3

TABLE 4-5

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
MONITORING WELL SAMPLES - 3/21/79

Priority Pollutant Found	Well Number							
	B-129	B-130	B-131	B-132	B-133	B-134	B-135	B-136
Benzene	-	-	-	-	-	-	15	-
Methlylene Chloride	-	30	-	37	52	38	20	35
Ethylbenzene	-	-	-	-	-	-	18	-
Toluene	-	-	-	-	-	-	1,629	-
Arsenic	240	260	-	-	25	640	110	240
Chromium	-	-	-	-	120	140	61	60
Lead	-	-	-	-	-	64	470	560
Nickel	-	96	-	-	230	410	68	620
Selenium	120	-	63	-	27	150	90	30
Diethyl Phthalate	-	-	-	-	-	-	10	-

Results are given in μg/l
It appears from the analytical report that all the priority pollutants except asbestos were analyzed for. Only the compounds listed were found.
Samples taken by Fred C. Hart Associates.
- : Indicates not analyzed for.

#17
PG 1 of 1

TABLE 4-6

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE

Well	April 1, 1980 Temperature (°C)	April 1, 1980 Specific Conductance (μmho/cm)	April 11, 1980 Temperature (°C)	April 11, 1980 Specific Conductance (μmho/cm)
1	14	540	-	-
2	12	400	-	-
2a	11	480	-	-
3	12	2,300	-	-
4	11	210	-	-
4a	8	340	-	-
5	12	160	-	-
5a	8	580	-	-
6	12	165	-	-
7	17	1,850	-	-
8	12.5	280	12	340
8a	-	-	12	380
9	8.5	1,520	-	-
10	12.5	310	-	-
10a	-	-	13	260
11	12.5	1,420	-	-
12	12.5	880	11	1,180
13	10	1,600	10	1,500
14	12	440	-	-
15	12	4,800	11	2,900
16	12	2450	-	-
17	12	190	-	-
18	11	144	8.5	240
20	-	-	8	112
21	-	-	16	103

Pb 1/9/1
#18

Note: The specific conductance is compensated to a temperature of 25°C.
Analysis performed by Leonard Jackson Associates.
Dashes indicate the analysis was not performed.

TABLE 4-1

WASTE ANALYSIS
RAMAPO LANDFILL SITE

UNKNOWN LOCATION
NO QA/QC DATA GIVEN

Parameter	Sludge-like Material 10/11/80
Phenol	78
Fluoranthene	250
Bis(2-ethylhexyl)phthalate	60
Diethyl Phthalate	54
Phenanthrene	340
Pyrene	160
Silver (mg/kg)	0.20
Arsenic (mg/kg)	6.0
Beryllium (mg/kg)	0.28
Chromium (mg/kg)	11
Copper (mg/Lg)	40
Mercury (mg/kg)	0.24
Lead (mg/kg)	18
Nickel (mg/kg)	15
Antimony (mg/kg)	2
Selenium (mg/kg)	0.32
Zinc (mg/kg)	32
1,1,1-Trichloroethane	7.1
1,1-Dichloroethane	2.8
Ethylbenzene	0.60
Methylene Chloride	3.2
Tetrachloroethylene	12.0
Toluene	4.0
Trichloroethylene	1.0

QC #20
pg 1/1

Note: The sample was analyzed for all the priority pollutants except asbestos and cyanide. Only the compounds found are listed.
All resulted are in µg/kg except as noted.
Analysis performed by the USEPA, Region II.

TABLE 4-10

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE

Laboratory Number: Priority Pollutants	Leachate Late 1982 NYTL R-3064-01	Well #16 Late 1982 NYTL R-3064-02	Well #3 Late 1980 NYTL R-3064-03	Leachate (inflow) 10/11/82 USEPA 50249	Leachate (outflow) 10/11/80 USEPA 50248	Leachate 3/15/83 NYTL 86-64452
Total Phenol	25	39	25	-	-	-
Chromium	46	-	-	-	20	NA
Copper	17	34	295	5.0	45	NA
Zinc	34	126	263	1,100	230	NA
Nickel	-	38	163	-	30	NA
Selenium	-	-	1	-	-	NA
Arsenic	-	-	3	100	85	NA
Benzene	-	19	-	0.70	-	NA
Acenaphthene	-	-	-	0.40	-	NA
1,4 Dichlorobenzene	-	-	-	2.2	-	NA
1,2 Diphenylhydrazene	-	-	-	0.80	0.40	NA
Fluoranthene	-	-	-	0.10	0.60	NA
N-Nitrosodiphenylamine	-	-	-	3.7	-	NA
Bis(2-ethylhexyl)phthalate	-	-	-	4.1	47.0	NA
Butyl benzyl phthalate	-	-	-	2.2	4.6	NA
Diethyl phthalate	-	-	-	2.2	0.70	NA
Anthracene	-	-	-	0.40	-	NA
Phenanthrene	-	-	-	0.50	0.30	NA
Silver	-	-	-	3.0	-	NA
Beryllium	-	-	-	160	13	NA
Cadmium	-	-	-	7.0	6	NA
Lead	-	-	-	50	30	NA
Antimony	-	-	-	50	-	NA
Chlorobenzene	-	-	-	0.60	-	NA
Ethyl benzene	-	-	-	0.50	-	NA
Toluene	-	-	-	0.30	0.20	NA
Di-n-butylphthalate	-	-	-	-	7.3	NA
Mercury	-	-	-	-	0.31	NA
Methylene Chloride	-	-	-	-	0.90	-
Chloroform	-	-	-	-	-	2
1,1,2,2-Tetrachloroethane	-	-	-	-	-	2
Di-octyl-phthalate	-	-	-	-	-	700

#21,25
PG 1 of 2

TABLE 4-10
GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
PAGE TWO

Note: The three samples form Late 1982 were analyzed for all the priority pollutants except dioxin, the two samples from October 1980 were analyzed for all the priority pollutants, and the 1983 sample was analyzed for all the priority pollutants except for metals, cyanide, dioxin, and pesticides. None of the samples were analyzed for asbestos.

Results are given in µg/l. Only the compounds detected are listed.
NYTL: New York Testing Laboratory, Inc.
- : Not Detected
NA: Not Analyzed

#21,25
PG 2 of 2

TABLE 4-7

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
MONITORING WELL DATA - NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
2/4/81

Sampling Site	Well #1	Well #2	Well #2A	Well #3	Well #7	Well #11A	Well #4A	Well #6
Lab. Number	81-035-01	81-035-02	81-035-03	81-035-04	81-035-05	81-035-06	81-040-01	81-040-02
Parameter								
pH (Lab)	7.36	7.77	7.76	6.55	7.04	6.60	6.70	6.60
TDS	407	563	1,167	1,182	1,255	1,459	165	95
SO_4	28	26	31	13	7	10	29	26
NO_3	0.12	0.10	0.36	1.72	0.84	2.00	0.84	1.98
Cl	81	98	315	200	250	315	35	15
CN	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2
Phenol	0.02	0.03	0.41	0.53	0.28	NA	0.18	0.02
Hardness	139	129	165	272	410	412	37	27
Na	10.6	10.9	64.4	71.6	103.2	100.0	15.4	2.6
Cu	LT 0.01	LT 0.01	0.21	0.07	LT 0.01	LT 0.01	0.21	LT 0.01
Cd	LT 0.01	LT 0.01	0.02	0.01	0.01	0.09	0.01	0.02
Fe	24.5	2.87	75.75	0.614	33.45	106.35	99.0	20.9
Zn	0.26	0.06	0.98	0.22	0.13	0.22	0.09	0.40
Pb	LT 0.01	LT 0.01	LT 0.01	LT 0.01	LT 0.01	0.14	0.09	0.21
Toluene	ND	ND	ND	1.815	ND	0.605	ND	ND
M+O-Xylene	ND	ND	ND	0.481	ND	ND	ND	ND
P-Xylene	ND	ND	ND	0.138	ND	ND	ND	ND

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PG1of4

TABLE 4-7
GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
MONITORING WELL DATA - NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
2/4/81
PAGE TWO

Sampling Site Lab. Number Parameter	Well #9 81-040-03	Well #13SC 81-040-04	Well #13 81-035-07	Well #14 81-035-08	Well #15 81-035-09	Well #16 81-035-10	Well #12 81-035-11	Well #21 81-035-12
pH (Lab)	7.17	7.42	6.77	7.12	10.74	6.77	6.44	7.24
TDS	1,929	391	1,921	861	186	1,898	1,865	16
SO_4	LT 3.0	18	27	53	30	10	24	14
NO_3	4.60	0.18	0.89	0.31	0.16	2.10	0.88	0.44
Cl	445	75	470	185	20	195	295	15
CN	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2
Phenol	0.89	0.03	-	0.91	0.02	-	-	0.09
Hardness	302	123	603	291	46	651	258	12
Na	278	4.8	180	64.7	9.0	108.8	97.5	3.4
Cu	0.16	LT 0.01	LT 0.01	LT 0.01	LT 0.01	LT 0.01	LT 0.01	LT 0.01
Cd	0.01	0.02	LT 0.01	LT 0.01	0.01	0.01	0.01	0.02
Fe	46.4	0.62	70.55	24.36	0.87	173.75	76.35	4.13
Zn	LT 0.01	0.09	0.04	0.07	0.10	0.10	0.47	0.22
Pb	0.35	LT 0.01	0.14	0.03	0.02	0.07	0.99	0.01
Toluene	ND	ND	ND	ND	ND	2.475	ND	ND
M+O-Xylene	ND	ND	ND	ND	ND	0.550	ND	ND
P-Xylene	0.040	ND	ND	ND	ND	0.112	ND	ND

ND: Not Detected
LT: Less Than
All results given in mg/l
NA: Is assumed to mean not analyzed.
It is unknown what the dashes indicate although not analyzed seems likely.

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PG 2 of 4

#22 PG 3 of 4

TABLE 4-8

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, 2/18/81

	Sampling Site/Laboratory Number					
Parameter	44SO2UO1 81-049-01	44SO2U02 81-049-02	44SO2D01 81-049-03	44SO2DO2 81-049-04	44SO2DO3 81-049-05	81-049-06
Phenol	0.09	0.05	0.16	0.33	0.16	0.20
Cu	LT 0.01	LT 0.01	3.58	0.46	LT 0.01	LT 0.01
Cd	LT 0.01	LT 0.01	0.01	0.02	0.01	LT 0.01
Fe	0.72	0.38	207	228	2.89	3.9
Zn	LT 0.01	0.07	7.2	0.71	0.12	0.11
Cr	LT 0.01	LT 0.01	0.11	0.10	0.01	0.02
Pb	0.01	LT 0.01	0.08	0.09	0.02	0.04
Ni	LT 0.01	LT 0.01	0.74	0.05	LT 0.01	LT 0.01

LT: Less Than
Results given in mg/l

TABLE 4-9

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, 3/11/81

	Well Sampled/Laboratory Numbers						
Parameter	Well #5 81-035-01	Well #5A 81-035-02	Well #8 81-035-03	Well #8A 81-035-04	Well #10 81-035-05	Well #10A 81-035-06	Well #18 81-040-07
pH (Lab)	2.60	6.73	7.45	7.26	7.02	6.22	6.08
SO_4	43.0	20.0	40.0	1950.0	18.5	60.0	80.0
NO_3	0.17	0.15	0.18	0.17	0.155	0.25	Interface
Cl	169.9	18.0	16.0	38.0	13.0	17.0	2.0
Hardness	38.5	23.5	59.9	117.7	38.5	47.1	17.1
Fe	25.75	1.62	0.50	9.10	6.07	180.5	0.76
Zn	0.18	0.12	0.10	0.09	0.14	0.24	0.13

Results given in mg/l

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PG 4 of 4

Ramapo Sanitary Landfill

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
ORADELL, NEW JERSEY

#23
PG 1 of 1

SV

VOLATILE ORGANIC ANALYSIS

DATE COLLECTED 3-11-81

DATE ANALYZED 3-21-81

DATE. 3-23-81

PARAMETERS	SAMPLE IDENTIFICATION AND CONCENTRATION				
	Well #3	Well # 5	Well # 5A	Well # 8A	Well #1
CHLOROMETHANE					
BROMOMETHANE					
DICHLORODIFLUOROMETHANE					
VINYL CHLORIDE					
CHLOROETHANE					
METHYLENE CHLORIDE	ND	ND	ND	ND	ND
TRICHLOROFLUOROMETHANE					
1,1-DICHLOROETHANE					
1,1-DICHLOROETHYLENE					
1,2-DICHLOROETHYLENE					
CHLOROFORM *	ND	ND	ND	ND	ND
1,2-DICHLOROETHANE	ND	ND	ND	ND	ND
1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND
BROMODICHLOROMETHANE *	ND	ND	ND	ND	ND
1,2-DICHLOROPROPANE					
1,3-DICHLOROPROPYLENE					
TRICHLOROETHYLENE	ND	ND	ND	ND	ND
DIBROMOCHLOROMETHANE *	ND	ND	ND	ND	ND
1,1,2-TRICHLOROETHANE					
2-CHLOROETHYLVINYL ETHER					
BROMOFORM *	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE					
TETRACHLOROETHYLENE (PER-)	ND	ND	ND	ND	ND
CHLOROBENZENE					
1,3-DICHLOROBENZENE					
1,2-DICHLOROBENZENE					
1,4-DICHLOROBENZENE					
TTHMs (SEE NOTE)					
HACKENSACK WATER Co. LAB No.	382	383	384	385	38

RESULTS EXPRESSED IN PARTS PER BILLION UNLESS OTHERWISE STATED.
NOTE TOTAL TRIHALOMETHANES (TTHMs) - SUM OF FOUR COMPOUNDS INDICATED BY ASTERISKS (*).
N.D. - NOT DETECTABLE
N.A. - NOT APPLICABLE

H#SV-220

Leo C. Fung
LEO C FUNG, CHIEF CHEMIST

1982 ANALYTIC RESULTS FROM THE ROUTINE TOXICS SURVEILLANCE NETWORK NEAR PROBLEM LANDFILLS

(1) Santapogue Creek Downstream of the Babylon Landfill for Heavy Metals

(2) Freshkills Creek Downstream from the Freshkills Landfill for Heavy Metals, BTX, VHO, PCB's and Part 5 Pesticides

(3) Torne Brook Dwonstream of the Torne Valley Landfill for Heavy Metals, BTX and VHO

(4) Delaware River Downstream from Cortese Landfill for Heavy Metals, BTX and VHO

(5) Matthew Creek Below Johnstown Landfill for Heavy Metals, BTX and VHO

(6) Feedertow Canal Below Kingsbury and Fort Edward Landfills for Heavy Metals and PCB's (Water and Sediment)

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(7) Geddes Brook Downstream of Onondaga Landfill for Heavy Metals

(8) Black Brook at Montezuma National Refuge Wetland Downstream from Seneca Falls (Tantalo) Landfill for Heavy Metals, BTX, VHO, PCB's and Part 5 Pesticides

(9) Tonawanda Creek Below Batavia Landfill for Heavy Metals, VHO and Part 5 Pesticides

(10) Two Mile Creek Downstream of Niagara (Seaway) Landfill for Heavy Metals, BTX, VHO and PCB's

(11) Hosmer Brook Downstream of Chaffee Landfill for Heavy Metals, BTX, VHO and PCB's

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NEW YORK STATE DEPARTMENT OF HEALTH
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ENVIRONMENTAL HEALTH CENTER

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RESULTS OF EXAMINATION
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LAB ACCESSION NO: 21045 YR/MO/DAY/HR SAMPLE REC'D: 82/06/03/11

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBWSHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DNSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/01/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	1.	LT
334409	BENZENE	MCG/L	1.	LT
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	1.	LT
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	1.	LT

#24
Pl. 20/25

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RESULTS OF EXAMINATION
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LAB ACCESSION NO: 21085 YR/MO/DAY/HR SAMPLE REC'D: 82/06/03/11

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/01/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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LAB ACCESSION NO: 21045 YR/MO/DAY/HR SAMPLE REC'D: 82/06/03/11

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/01/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

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RESULTS OF EXAMINATION

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LAB ACCESSION NO: 07058 YR/MO/DAY/HR SAMPLE REC'D: 82/06/07/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/01/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	
010901	ZINC	MG/L	0.05	LT
011201	ANTIMONY	MG/L	1.	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309809	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

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RESULTS OF EXAMINATION
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LAB ACCESSION NO: 22465 YR/MO/DAY/HR SAMPLE REC'D: 82/10/20/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 10/19/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	1.	LT
334409	BENZENE	MCG/L	②.	
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	①	
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	1.	LT

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ENVIRONMENTAL HEALTH CENTER

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LAB ACCESSION NO: 22465 YR/MO/DAY/HR SAMPLE REC'D: 82/10/20/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 10/19/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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LAB ACCESSION NO: 22465 YR/MO/DAY/HR SAMPLE REC'D: 82/10/20/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 10/19/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

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RESULTS OF EXAMINATION
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LAB ACCESSION NO: 07402 YR/MO/DAY/HR SAMPLE REC'D: 82/10/25/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 10/19/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	LT
010901	ZINC	MG/L	0.1	LT
011201	ANTIMONY	MG/L	0.5	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309809	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

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RESULTS OF EXAMINATION
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LAB ACCESSION NO: 21341 YR/MO/DAY/HR SAMPLE REC'D: 82/06/30/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WIT RAMAPO RIVER 0930
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/29/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

	PARAMETER	UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	1.	LT
334409	BENZENE	MCG/L	1.	
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	1.	LT
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	2.	

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LAB ACCESSION NO: 21341 YR/MO/DAY/HR SAMPLE REC'D: 82/06/30/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WIT RAMAPO RIVER 0930
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/29/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
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LAB ACCESSION NO: 21341 YR/MO/DAY/HR SAMPLE REC'D: 82/06/30/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WIT RAMAPO RIVER 0930
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/29/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

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Pg 120

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NEW YORK STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 1 OF 1)

LAB ACCESSION NO: 07126 YR/MO/DAY/HR SAMPLE REC'D: 82/07/02/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER 0930
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 06/29/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	
010901	ZINC	MG/L	0.05	LT
011201	ANTIMONY	MG/L	1.	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309809	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

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PG 13 of 25

DATE PRINTED: 8/11/82

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50 WOLF ROAD
ALBANY, N.Y. 12233

SUBMITTED BY: ESTABROOK

NEW YORK STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

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RESULTS OF EXAMINATION
(PAGE 1 OF 3)

LAB ACCESSION NO: 21660 YR/MO/DAY/HR SAMPLE REC'D: 82/07/29/09

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER 1005
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 07/27/10
REPORT SENT TO: CO (2) RC (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	1.	SU
334409	BENZENE	MCG/L	1.	LT
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	1.	LT
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	1.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 2 OF 3)

LAB ACCESSION NO: 21660 YR/MO/DAY/HR SAMPLE REC'D: 82/07/29/09

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER 1005
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 07/27/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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DATE PRINTED: 8/13/82

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RESULTS OF EXAMINATION
(PAGE 3 OF 3)

LAB ACCESSION NO: 21660 YR/MO/DAY/HR SAMPLE REC'D: 82/07/29/09

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND,
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER 1005
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 07/27/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
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LAB ACCESSION NO: 07205 YR/MO/DAY/HR SAMPLE REC'D: 82/07/30/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 07/27/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	
010901	ZINC	MG/L	0.05	LT
011201	ANTIMONY	MG/L	1.	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309809	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

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ENVIRONMENTAL HEALTH CENTER

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RESULTS OF EXAMINATION
(PAGE 1 OF 3)

LAB ACCESSION NO: 22145 YR/MO/DAY/HR SAMPLE REC'D: 82/09/21/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 09/20/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	9.	SU
334409	BENZENE	MCG/L	1.	LT
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	1.	LT
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	1.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 2 OF 3)

LAB ACCESSION NO: 22145 YR/MO/DAY/HR SAMPLE REC'D: 82/09/21/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 09/20/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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ENVIRONMENTAL HEALTH CENTER

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RESULTS OF EXAMINATION
(PAGE 3 OF 3)

LAB ACCESSION NO: 22145 YR/MO/DAY/HR SAMPLE REC'D: 82/09/21/15

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 09/20/10
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT . FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 1 OF 1)

LAB ACCESSION NO: 07343 YR/MO/DAY/HR SAMPLE REC'D: 82/09/27/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 09/20/10
REPORT SENT TO: CO (2) RC (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	
010901	ZINC	MG/L	0.05	LT
011201	ANTIMONY	MG/L	1.	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309909	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 1 OF 3)

LAB ACCESSION NO: 21919 YR/MO/DAY/HR SAMPLE REC'D: 82/08/25/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENT WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 08/24/99
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
070309	META XYLENE	MCG/L	1.	LT
070409	PARA XYLENE	MCG/L	1.	LT
151409	ORTHO XYLENE	MCG/L	1.	LT
323609	1,1,1-TRICHLOROETHANE	MCG/L	1.	LT
323809	DICHLOROMETHANE	MCG/L	1.	LT
334409	BENZENE	MCG/L	1.	LT
336609	CARBON TETRACHLORIDE	MCG/L	1.	LT
338909	BROMODICHLOROMETHANE	MCG/L	1.	LT
339009	CHLOROFORM	MCG/L	1.	LT
339209	TOLUENE	MCG/L	1.	LT
340909	CHLOROBENZENE	MCG/L	1.	LT
341009	VINYL CHLORIDE	MCG/L	1.	LT
341209	TETRACHLOROETHENE	MCG/L	1.	LT

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DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 2 OF 3)

LAB ACCESSION NO: 21919 YR/MO/DAY/HR SAMPLE REC'D: 82/08/25/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENT WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 08/24/99
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
342109	BROMOFORM	MCG/L	1.	LT
344109	1,2-DICHLOROBENZENE	MCG/L	1.	LT
344209	1,4-DICHLOROBENZENE	MCG/L	1.	LT
344909	DIBROMOCHLOROMETHANE	MCG/L	1.	LT
349709	1,3-DICHLOROBENZENE	MCG/L	1.	LT
350809	1,2-DICHLOROETHANE	MCG/L	1.	LT
350909	1,1-DICHLOROETHENE	MCG/L	1.	LT
351009	ETHYLBENZENE	MCG/L	1.	LT
351709	1,1,2-TRICHLOROETHANE	MCG/L	1.	LT
351809	1,1,2,2-TETRACHLOROETHANE	MCG/L	1.	LT
351909	1,1-DICHLOROETHANE	MCG/L	1.	LT
361109	2-CHLOROETHYLVINYL ETHER	MCG/L	1.	LT
361209	TRANS 1,2-DICHLOROETHENE	MCG/L	1.	LT

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ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 3 OF 3)

LAB ACCESSION NO: 21919 YR/MO/DAY/HR SAMPLE REC'D: 82/08/25/16

REPORTING LAB: 17 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUBW'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENT WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 08/24/99
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (1)

PARAMETER		UNIT	RESULT	NOTATION
361309	1,2-DICHLOROPROPANE	MCG/L	1.	LT
361409	CIS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361509	TRANS 1,3-DICHLOROPROPENE	MCG/L	1.	LT
361609	TRICHLOROETHENE	MCG/L	1.	LT
361709	TRICHLOROFLUROMETHANE	MCG/L	1.	LT
361809	BROMOMETHANE	MCG/L	1.	LT
361909	CHLOROETHANE	MCG/L	1.	LT
362009	CHLOROMETHANE	MCG/L	1.	LT
370209	DICHLORODIFLUORMETHANE	MCG/L	1.	LT

#2A
Ru2A01

DATE PRINTED: 9/10/82

MR.F.ESTRABROOKS,RM.300,TOXIC TRACKDOWNS
NYS.DEPT.OF ENVIRONMENTAL CONSERVATION
50 WOLF ROAD
ALBANY, N.Y. 12233

SUBMITTED BY: ESTABROOK

1215

NEW YORK STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORIES AND RESEARCH
ENVIRONMENTAL HEALTH CENTER

FINAL REPORT FINAL REPORT FINAL REPORT

RESULTS OF EXAMINATION
(PAGE 1 OF 1)

LAB ACCESSION NO: 07266 YR/MO/DAY/HR SAMPLE REC'D: 82/08/30/11

REPORTING LAB: 10 EHC ALBANY
PROGRAM: 570 TOXICS SURVEILLANCE, D.E.C.
STATION (SOURCE) NO: 31501161
DRAINAGE BASIN: 15 NY GAZETTEER NO: 4353 COUNTY: ROCKLAND
COORDINATES: 41 DEG 08' 20"N, 74 DEG 09' 47"W
COMMON NAME INCL SUB'SHED: TORNE BROOK AT CONFLUENCE WITH RAMAPO RIVER
DWSTR OF TORNE VALLEY LANDFILL
EXACT SAMPLING POINT: AT CONFLUENCE WITH RAMAPO RIVER
TYPE OF SAMPLE: 21 SURFACE WATER
MO/DAY/HR OF SAMPLING: FROM 00/00 TO 08/24/11
REPORT SENT TO: CO (2) RO (0) LPHE (0) LHO (0) FED (0) CHEM (0)

PARAMETER		UNIT	RESULT	NOTATION
009501	BERYLLIUM	MG/L	0.02	LT
009901	COPPER	MG/L	0.05	LT
010309	MERCURY, TOTAL	MCG/L	0.4	LT
010601	SILVER	MG/L	0.02	LT
010901	ZINC	MG/L	0.05	LT
011201	ANTIMONY	MG/L	1.	LT
012801	NICKEL	MG/L	0.05	LT
014301	THALLIUM	MG/L	1.	LT
309309	ARSENIC	MCG/L	10.	LT
309709	CADMIUM	MCG/L	2.	LT
309809	CHROMIUM	MCG/L	10.	LT
310109	LEAD	MCG/L	10.	LT
310509	SELENIUM	MCG/L	5.	LT

#24
P6259
25

DATE PRINTED: 10/08/82

MR.F.ESTRABROOKS, RM.300, TOXIC TRACKDOWNS
NYS.DEPT.OF ENVIRONMENTAL CONSERVATION
50 WOLF ROAD
ALBANY, N.Y. 12233

SUBMITTED BY: ESTABROKS

SANITARY SCIENCE & LABORATORIES, INC.

555 ROUTE 94, NEW WINDSOR · NEWBURGH, NEW YORK 12550 · PHONE 914 562-4392

RECEIVED
NOV 28 1983
N.Y.S. D.E.C.
NEW PALTZ

EXAMINATION OF MATERIAL FROM LANDFILL

Sample No.:	83-1155	Date Reported:	18 November 1983
Work Order No.:	534	Date Collected:	2 November 1983
Purchase Order No.:	---	Date Received:	2 November 1983
Client Sample No.:	---	Time Sampled:	---

Client: Town of Ramapo, Attn: Mr. Gene Ostertag
Address: Dept. of Public Works, Town Hall, Route 59, Suffern, NY 10901
Sampling Point: Landfill
Collectec by: Town employee

RESULTS

The sample as received consisted of fist-sized chunks of a rubbery solid which appeared to be dried paint. A slice was cut from the center of each chunk. The slices were shredded and combined. A portion of the composite sample was analyzed directly for aromatic hydrocarbons with results as follows:

Benzene	13 mg/kg
Ethylbenzene	68 mg/kg
Toluene	88 mg/kg
Total Xylenes	260 mg/kg

#26
Pg 1/2

Another portion of the composite sample was used for an EP Toxicity Extraction which was performed as described in the Federal Register, Vol. 45, No. 98, p. 33127. The extract was analyzed for the following metals with results as listed (mg/l)

Arsenic	less than 0.025
Barium	0.80
Cadmium	0.04
Chromium	less than 0.01
Lead	129
Mercury	0.0005
Selenium	less than 0.001
Silver	less than 0.01

Town of Ramapo
Sample No. 83-1155

Page 2 of 2
18 November 1983

The presence of the aromatic hydrocarbons and the concentration of lead in the EP Toxicity Extract indicate that the material tested is a hazardous waste.

#26
Pg 2 of 2

By: Ila G. Fulton
Ila G. Fulton, Ph.D.
Laboratory Director

TABLE 4-12

GROUNDWATER ANALYSIS
RAMAPO LANDFILL SITE
LEACHATE ANALYSIS FROM NPDES PERMIT APPLICATION - 1983

Parameter	Result
BOD	2,751
COD	4,426
TOC	400
Total Suspended Solids	240
Ammonia	265
pH (Units)	7.3
Color (Units)	300
Fluoride	0.66
Iron	50
Manganese	12
Arsenic	0.021
Cadmium	0.009
Chromium	0.061
Copper	0.295
Lead	0.140
Nickel	0.163
Selenium	0.10
Zinc	1.36
Cyanide	0.001
Total Phenols	0.039
Benzene	0.019
Chloroform	0.002
1,1,2,2-Tetrachloroethane	0.002
Tetrachloroethylene	0.003
Phenol	0.08
Di-n-octylphthalate	0.70

Pg 1 of 1
#27

Note: All resulted are in µg/l unless noted.

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-001 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
PL LOCATION: well 2

REPORT TO: same
BILL TO: same

COLI:
F COLI:
Pu :
:
NO3 :
NO2 :
-PO4 :
u-PO4 :
SO4 :
BAS :
iO2 :
H2S :
H3-C :

VSS :
TS :
S :
DS : 290
SS :
SOL :
& O :
Al :
b : <0.1
s : <5.0 ug/l
Ba :
Be : <0.005
d : <0.01

Cr+6 :
Phenol: <0.01
CN : <0.005
B :
Br :
Color :
Odor :
Turb :
pH : 8.0
LI :
Cond : 320 umhos
NH3-T :
TKN :

Ca :
Cr : <0.02
Co :
Cu : 0.01
Au :
Fe : 0.57
Pb : 0.13
Mg :
Mn : 0.44
Hg : <0.4 ug/l
Mo :
Ni : <0.04
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 32
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se : <2.0 ug/l
Ag : 0.005
Na :
Tl : <0.1
Sn :
Ti :
V :
Zn : 0.06
THM :
TOC : 1.5

#30
Pg 10/33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

New York State Department of Health Approved

AB #63559-001

Client: (T) Ramapo Landfill Sol Location: Well #2

Sol Coll'd: 4/6/88 Sample Rec'd: 4/6/88

PA Method 624 Volatile Organics GC/MS

	COMPOUND	RESULTS		BLANK
		Sample Concen. ug/l	MDL ug/l	Conc. ug/l
1)	Acrolein	ND	100	ND
2)	Acrylonitrile	ND	100	ND
3)	Benzene	ND	5.0	ND
4)	Bromodichloromethane	ND	5.0	ND
5)	Bromoform	ND	5.0	ND
6)	Bromomethane	ND	5.0	ND
7)	Carbon Tetrachloride	ND	5.0	ND
8)	Chlorobenzene	ND	5.0	ND
9)	Chloroethane	ND	5.0	ND
10)	2-Chloroethylvinyl ether	ND	5.0	ND
11)	Chloroform	ND	5.0	ND
12)	Chloromethane	ND	5.0	ND
13)	Cis-1,3-dichloropropene	ND	5.0	ND
14)	Dibromochloromethane	ND	5.0	ND
15)	1,2-Dichlorobenzene	ND	5.0	ND
16)	1,3-Dichlorobenzene	ND	5.0	ND
17)	1,4-Dichlorobenzene	ND	5.0	ND
18)	1,1-Dichloroethane	ND	5.0	ND
19)	1,2-Dichloroethane	ND	5.0	ND
20)	1,1-Dichloroethene	ND	5.0	ND
21)	1,2-Dichloropropane	ND	5.0	ND
22)	Ethylbenzene	ND	5.0	ND
23)	Methylene chloride	ND	5.0	ND
24)	1,1,2,2-Tetrachloroethane	ND	5.0	ND
25)	Tetrachloroethene	ND	5.0	ND
26)	Toluene	ND	5.0	ND
27)	trans-1,3-Dichloropropene	ND	5.0	ND
28)	trans-1,2-Dichloroethylene	ND	5.0	ND
29)	1,1,1-Trichloroethane	ND	5.0	ND
30)	1,1,2-Trichloroethane	ND	5.0	ND
31)	Trichloroethene	ND	5.0	ND
32)	Trichlorofluoromethane	ND	5.0	ND
33)	Vinyl chloride	ND	5.0	ND
34)	Total Xylenes	ND	5.0	ND

#30
Pg 20/33

For EnviroTest Laboratories, Inc.

Ronald A. Baver
President

4/15/88

LAB # 60559-001

Client: Pomaco Landfill   Col Location: Well #2

Col Coll'd: 4/6/88   Sample Rec'd: 4/6/88

EFA Method 625 Acid Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) p-Chloro-m-Cresol	ND	10	ND
2) 2-Chlorophenol	ND	10	ND
3) 2.4-Dichlorophenol	ND	10	ND
4) 2.4-Dimethylphenol	ND	10	ND
5) 2.4-Dinitrophenol	ND	20	ND
6) 4.6-Dinitro-o-Cresol	ND	20	ND
7) 2-Nitrophenol	ND	10	ND
8) 4-Nitrophenol	ND	20	ND
9) Pentachlorophenol	ND	10	ND
10) Phenol	ND	10	ND
11) 2.4.6-Trichlorophenol	ND	10	ND

#30
PL 30/33

For EnviroTest Laboratories, Inc.

Ronald A. Beyer
President   25/88

LAB # 87559-001

Client: Ramapo Landfill   Spl Location: Well #2

Spl. Coll'd: 4/6/88   Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) Acenaphthene	ND	10	ND
2) Acenaphthylene	ND	10	ND
3) Anthracene	ND	10	ND
4) Benzidine	ND	10	ND
5) Benzo(a)Anthracene	ND	10	ND
6) Benzo(a)Pyrene	ND	10	ND
7) Benzo(b)Fluoranthene	ND	10	ND
8) Benzo(g,h,i)Perylene	ND	10	ND
9) Benzo(k)Fluoranthene	ND	10	ND
10) Bis(2-Chloroethoxy)Methane	ND	10	ND
11) Bis(2-Chloroethyl)Ether	ND	10	ND
12) Bis(2-Chloroisopropyl)Ether	ND	10	ND
13) Bis(2-Ethylhexyl)phthalate	ND	10	ND
14) 4-Bromophenylphenylether	ND	10	ND
15) Butyl Benzyl Phthalate	ND	10	ND
16) 2-Chloronaphthalene	ND	10	ND
17) 4-Chlorophenylphenylether	ND	10	ND
18) Chrysene	ND	10	ND
19) Dibenzo(a,h)Anthracene	ND	10	ND
20) 1,2-Dichlorobenzene	ND	10	ND
21) 1,3-Dichlorobenzene	ND	10	ND
22) 1,4-Dichlorobenzene	ND	10	ND
23) 3,3'-Dichlorobenzidine	ND	10	ND
24) Diethyl Phthalate	ND	10	ND
25) Dimethyl Phthalate	ND	10	ND
26) Di-N-Butyl Phthalate	ND	10	ND
27) 2,4-Dinitrotoluene	ND	10	ND
28) 2,6-Dinitrotoluene	ND	10	ND
29) Di-N-Octyl Phthalate	ND	10	ND
30) 1,2-Diphenylhydrazine	ND	10	ND
31) Fluoranthene	ND	10	ND

#30
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LAB # A7559-001

Client: Ramapo Landfill　　　　Sol Location: Well #2

Sol Coll'd: 4/6/88　　　　Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS		BLANK
	Sample Concen. ug/l	MDL ug/l	Conc. ug/l
32) Fluorene	ND	10	ND
33) Hexachlorobenzene	ND	10	ND
34) Hexachlorobutadione	ND	10	ND
35) Hexachlorocyclopentadiene	ND	10	ND
36) Hexachloroethane	ND	10	ND
37) Indeno(1,2,3-cd) Pyrene	ND	10	ND
38) Isophorone	ND	10	ND
39) Naphthalene	ND	10	ND
40) Nitrobenzene	ND	10	ND
41) N-Nitrosodimethylamine	ND	10	ND
42) N-Nitrosodi-n-Propylene	ND	10	ND
43) N-Nitrosodiphenylamine	ND	10	ND
44) Phenanthrene	ND	10	ND
45) Pyrene	ND	10	ND
46) 1,2,4-Trichlorobenzene	ND	10	ND

#30
pg 5 of 33

For EnviroTest Laboratories, Inc.

Ronald A. [illegible]
President

4/22/88

Lab # [illegible]

Client: Pamaco Landfill   Smpl Location: Well #1

Smpl Coll d: 4/6/85   Sample Rec'd: 4/ /85

EPA Method 608   Pesticide/PCB   GC/EC

COMPOUND	RESULTS		BLANK
	Sample Conten. ug/l	MDL ug/l	Conc.
1) Alpha-BHC	ND	0.05	ND
2) Beta-BHC	ND	0.05	ND
3) Delta-BHC	ND	0.05	ND
4) Lindane	ND	0.05	ND
5) Heptachlor	ND	0.05	ND
6) Aldrin	ND	0.05	ND
7) Heptachlor epoxide	ND	0.05	ND
8) Endosulfan I	ND	0.05	ND
9) Dieldrin	ND	0.05	ND
10) 4.4'-DDE	ND	0.05	ND
11) Endrin	ND	0.05	ND
12) Endosulfan II	ND	0.05	ND
13) 4.4'-DDD	ND	0.05	ND
14) Endosulfan sulfate	ND	0.05	ND
15) 4.4'-DDT	ND	0.05	ND
16) Methoxychlor	ND	0.5	ND
17) Endrin Ketone	ND	0.1	ND
18) Chlordane	ND	0.5	ND
19) Toxaphene	ND	0.5	ND
20) PCB Aroclor 1016	ND	0.1	ND
21) PCB Aroclor 1221	ND	0.1	ND
22) PCB Aroclor 1232	ND	0.1	ND
23) PCB Aroclor 1242	ND	0.1	ND
24) PCB Aroclor 1248	ND	0.1	ND
25) PCB Aroclor 1254	ND	0.1	ND
26) PCB Aroclor 1260	ND	0.1	ND

#30
76 of 133

For EnviroTest Laboratories, Inc.

Ronald A. Bav[illegible]
President   [illegible]

EnviroTest
Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-002 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
PL LOCATION: well #3

REPORT TO: same
PILL TO: same

COLI:
F COLI:
PC :
:
NO3 :
O2 :
-PO4 :
O-PO4 :
SO4 :
BAS :
[illegible] :
H2S :
H3-C :

VSS :
S :
S :
TDS : 1000
SS :
SOL :
& O :
Al :
b : <0.1
s : 21 ug/l
Ba :
e : <0.005
d : <0.01

Cr+6 :
Phenol : 0.01
CN : <0.005
B :
Br :
Color :
Odor :
Turb :
pH : 6.6
LI :
Cond : 1400
NH3-T :
TKN :

Ca :
Cr : <0.02
Co :
Cu : 0.03
Au :
Fe : 37
Pb : 0.04
Mg :
Mn : 3.1
Hg : <0.4 ug/l
Mo :
Ni : <0.04
Pd :

COD :
HARD-T :
Ca Hard :
SO3 :
Cl : 400
Alk :
BOD-Inf :
BOD-Eff :
BOD-S :
TSS-Inf :
TSS-Eff :
MLSS :
MLVSS :

K :
Se : <2.0 ug/l
Ag : 0.005
Na :
Tl : <0.1
Sn :
Ti :
V :
Zn : 0.08
THM :
TOC : 21

#30
pg 7
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

New York State Department of Health Approved

LAB #63559-002

Client: (T) Ramapo Landfill　　Sol Location: Well #3

Sol Coll'd: 4/6/88　　Sample Rec'd: 4/6/88

EPA Method 624 Volatile Organics GC/MS

COMPOUND	RESULTS		BLANK
	Sample Concen. ug/l	MDL ug/l	Conc. ug/l
1) Acrolein	ND	100	ND
2) Acrylonitrile	ND	100	ND
3) Benzene	ND	5.0	ND
4) Bromodichloromethane	ND	5.0	ND
5) Bromoform	ND	5.0	ND
6) Bromomethane	ND	5.0	ND
7) Carbon Tetrachloride	ND	5.0	ND
8) Chlorobenzene	ND	5.0	ND
9) Chloroethane	ND	5.0	ND
10) 2-Chloroethylvinyl ether	ND	5.0	ND
11) Chloroform	ND	5.0	ND
12) Chloromethane	ND	5.0	ND
13) Cis-1,3-dichloropropene	ND	5.0	ND
14) Dibromochloromethane	ND	5.0	ND
15) 1,2-Dichlorobenzene	ND	5.0	ND
16) 1,3-Dichlorobenzene	ND	5.0	ND
17) 1,4-Dichlorobenzene	ND	5.0	ND
18) 1,1-Dichloroethane	ND	5.0	ND
19) 1,2-Dichloroethane	ND	5.0	ND
20) 1,1-Dichloroethene	ND	5.0	ND
21) 1,2-Dichloropropane	ND	5.0	ND
22) Ethylbenzene	ND	5.0	ND
23) Methylene chloride	ND	5.0	ND
24) 1,1,2,2-Tetrachloroethane	ND	5.0	ND
25) Tetrachloroethene	ND	5.0	ND
26) Toluene	ND	5.0	ND
27) trans-1,3-Dichloropropene	ND	5.0	ND
28) trans-1,2-Dichloroethylene	ND	5.0	ND
29) 1,1,1-Trichloroethane	ND	5.0	ND
30) 1,1,2-Trichloroethane	ND	5.0	ND
31) Trichloroethene	ND	5.0	ND
32) Trichlorofluoromethane	ND	5.0	ND
33) Vinyl chloride	ND	5.0	ND
34) Total Xylenes	ND	5.0	ND

#30
PL 8 of 33

For EnviroTest Laboratories, Inc.

Ronald A. Bauer
President　　4/15/88

LAB # 63559-002

Client: Ramapo Landfill   Sol Location: Well #3

Sol Coll'd: 4/6/88   Sample Rec'd: 4/6/88

EPA Method 625   Acid Extractables   GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	 MDL ug/l	BLANK Conc. ug/l
1) p-Chloro-m-Cresol	ND	10	ND
2) 2-Chlorophenol	ND	10	ND
3) 2,4-Dichlorophenol	ND	10	ND
4) 2,4-Dimethylphenol	ND	10	ND
5) 2,4-Dinitrophenol	ND	20	ND
6) 4,6-Dinitro-o-Cresol	ND	20	ND
7) 2-Nitrophenol	ND	10	ND
8) 4-Nitrophenol	ND	20	ND
9) Pentachlorophenol	ND	10	ND
10) Phenol	ND	10	ND
11) 2,4,6-Trichlorophenol	ND	10	ND

#30
pg 9 of 33

For EnviroTest Laboratories, Inc.

Ronald A. B[illegible]
President   4/25/88

Lab # 80559-002

Client: Ramapo Landfill

Smpl Location: Well #3

Smpl Coll'd: 4/6/88

Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) Acenaphthene	ND	10	ND
2) Acenaphthylene	ND	10	ND
3) Anthracene	ND	10	ND
4) Benzidine	ND	10	ND
5) Benzo(a)Anthracene	ND	10	ND
6) Benzo(a)Pyrene	ND	10	ND
7) Benzo(b)Fluoranthene	ND	10	ND
8) Benzo(g,h,i)Perylene	ND	10	ND
9) Benzo(k)Fluoranthene	ND	10	ND
10) Bis(2-Chloroethoxy)Methane	ND	10	ND
11) Bis(2-Chloroethyl)Ether	ND	10	ND
12) Bis(2-Chloroisopropyl)Ether	ND	10	ND
13) Bis(2-Ethylhexyl)phthalate	ND	10	ND
14) 4-Bromophenylphenylether	ND	10	ND
15) Butyl Benzyl Phthalate	ND	10	ND
16) 2-Chloronaphthalene	ND	10	ND
17) 4-Chlorophenylphenylether	ND	10	ND
18) Chrysene	ND	10	ND
19) Dibenzo(a,h)Anthracene	ND	10	ND
20) 1,2-Dichlorobenzene	ND	10	ND
21) 1,3-Dichlorobenzene	ND	10	ND
22) 1,4-Dichlorobenzene	ND	10	ND
23) 3,3'-Dichlorobenzidine	ND	10	ND
24) Diethyl Phthalate	ND	10	ND
25) Dimethyl Phthalate	ND	10	ND
26) Di-N-Butyl Phthalate	ND	10	ND
27) 2,4-Dinitrotoluene	ND	10	ND
28) 2,6-Dinitrotoluene	ND	10	ND
29) Di-N-Octyl Phthalate	ND	10	ND
30) 1,2-Diphenylhydrazine	ND	10	ND
31) Fluoranthene	ND	10	ND

#30
Pg 109
37

Lab # [illegible]-002

Client: Ramapo Landfill　　　　Spl Location: Well #3

Spl Coll'd: 4/6/88　　　　Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
32) Fluorene	ND	10	ND
33) Hexachlorobenzene	ND	10	ND
34) Hexachlorobutadiene	ND	10	ND
35) Hexachlorocyclopentadiene	ND	10	ND
36) Hexachloroethane	ND	10	ND
37) Indeno(1,2,3-cd) Pyrene	ND	10	ND
38) Isophorone	ND	10	ND
39) Naphthalene	ND	10	ND
40) Nitrobenzene	ND	10	ND
41) N-Nitrosodimethylamine	ND	10	ND
42) N-Nitrosodi-n-Propylene	ND	10	ND
43) Ni-Nitrosodiphenylamine	ND	10	ND
44) Phenanthrene	ND	10	ND
45) Pyrene	ND	10	ND
46) 1,2,4-Trichlorobenzene	ND	10	ND

#30
Pg 110

For EnviroTest Laboratories, Inc.

Ronald A. Ba[illegible]
President　　　　4/25/88

LAB # 87559-007

Client: Ramapo Landfill — Col Location: Well #3

Col Coll'd: 4/6/88 — Sample Rec'd: 4/6/88

EPA Method 608 Pesticide/PCB GC/EC

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc.
1) Alpha-BHC	ND	0.05	ND
2) Beta-BHC	ND	0.05	ND
3) Delta-BHC	ND	0.05	ND
4) Lindane	ND	0.05	ND
5) Heptachlor	ND	0.05	ND
6) Aldrin	ND	0.05	ND
7) Heptachlor epoxide	ND	0.05	ND
8) Endosulfan I	ND	0.05	ND
9) Dieldrin	ND	0.05	ND
10) 4.4'-DDE	ND	0.05	ND
11) Endrin	ND	0.05	ND
12) Endosulfan II	ND	0.05	ND
13) 4.4'-DDD	ND	0.05	ND
14) Endosulfan sulfate	ND	0.05	ND
15) 4.4'-DDT	ND	0.05	ND
16) Methoxychlor	ND	0.5	ND
17) Endrin Ketone	ND	0.1	ND
18) Chlordane	ND	0.5	ND
19) Toxaphene	ND	0.5	ND
20) PCB Aroclor 1016	ND	0.1	ND
21) PCB Aroclor 1221	ND	0.1	ND
22) PCB Aroclor 1232	ND	0.1	ND
23) PCB Aroclor 1242	ND	0.1	ND
24) PCB Aroclor 1248	ND	0.1	ND
25) PCB Aroclor 1254	ND	0.1	ND
26) PCB Aroclor 1260	ND	0.1	ND

#30

Pg 12 of

For EnviroTest Laboratories, Inc.

Ronald A. Ba[illegible]
President

4/25/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-003 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Close
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SPL LOCATION: well #4

REPORT TO: same
BILL TO:

T COLI		Cr+6		COD	
F COLI		Phenol	<0.01	HARD-T	
SPC		CN	<0.005	Ca Hard	
F		B		SO3	
NO3		Br		Cl	74
NO2		Color		Alk	
T-PO4		Odor		BOD-Inf	
O-PO4		Turb		BOD-Eff	
SO4		pH	6.8	BOD-S	
MBAS		LI		TSS-Inf	
SiO2		Cond	390 umhos	TSS-Eff	
H2S		NH3-T		MLSS	
NH3-C		TKN		MLVSS	
VSS		Ca		K	
TS		Cr	<0.02	Se	<2.0 ug/l
VS		Co		Ag	<0.005
TDS	470	Cu	0.17	Na	
SS		Au		Tl	<0.1
% SOL		Fe	1.6	Sn	
G & O		Pb	0.02	Ti	
Al		Mg		V	
Sb	<0.1	Mn	2.6	Zn	0.39
As	<5.0 ug/l	Hg	<0.4 ug/l	THM	
Ba		Mo		TOC	3.8
Be	<0.005	Ni	<0.04		
Cd	<0.01	Pd			

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Pg 13 of 22

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

LAB #62559-003

Client: (T) Ramapo Landfill　Spl Location: Well #4

Spl Coll'd: 4/6/88　Sample Rec'd: 4/6/88

EPA Method 624　Volatile Organics　GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) Acrolein	ND	100	ND
2) Acrylonitrile	ND	100	ND
3) Benzene	ND	5.0	ND
4) Bromodichloromethane	ND	5.0	ND
5) Bromoform	ND	5.0	ND
6) Bromomethane	ND	5.0	ND
7) Carbon Tetrachloride	ND	5.0	ND
8) Chlorobenzene	ND	5.0	ND
9) Chloroethane	ND	5.0	ND
10) 2-Chloroethylvinyl ether	ND	5.0	ND
11) Chloroform	ND	5.0	ND
12) Chloromethane	ND	5.0	ND
13) Cis-1,3-dichloropropene	ND	5.0	ND
14) Dibromochloromethane	ND	5.0	ND
15) 1,2-Dichlorobenzene	ND	5.0	ND
16) 1,3-Dichlorobenzene	ND	5.0	ND
17) 1,4-Dichlorobenzene	ND	5.0	ND
18) 1,1-Dichloroethane	ND	5.0	ND
19) 1,2-Dichloroethane	ND	5.0	ND
20) 1,1-Dichloroethene	ND	5.0	ND
21) 1,2-Dichloropropane	ND	5.0	ND
22) Ethylbenzene	ND	5.0	ND
23) Methylene chloride	ND	5.0	ND
24) 1,1,2,2-Tetrachloroethane	ND	5.0	ND
25) Tetrachloroethene	ND	5.0	ND
26) Toluene	ND	5.0	ND
27) trans-1,3-Dichloropropene	ND	5.0	ND
28) trans-1,2-Dichloroethylene	ND	5.0	ND
29) 1,1,1-Trichloroethane	ND	5.0	ND
30) 1,1,2-Trichloroethane	ND	5.0	ND
31) Trichloroethene	ND	5.0	ND
32) Trichlorofluoromethane	ND	5.0	ND
33) Vinyl chloride	ND	5.0	ND
34) Total Xylenes	ND	5.0	ND

#30
pg 140

For EnviroTest Laboratories, Inc.

Ronald A. Bauer
President

4/15/88

EnviroTest Laboratories Inc.

LAB # 80358-003

Client: Ramapo Landfill   Spl Location: Well #4

Spl Coll d: 4/4/88   Sample Rec'd: 4/6/88

EPA Method 625   Acid Extractables   GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) p-Chloro-m-Cresol	ND	10	ND
2) 2-Chlorophenol	ND	10	ND
3) 2,4-Dichlorophenol	ND	10	ND
4) 2,4-Dimethylphenol	ND	10	ND
5) 2,4-Dinitrophenol	ND	20	ND
6) 4,6-Dinitro-o-Cresol	ND	20	ND
7) 2-Nitrophenol	ND	10	ND
8) 4-Nitrophenol	ND	20	ND
9) Pentachlorophenol	ND	10	ND
10) Phenol	ND	10	ND
11) 2,4,6-Trichlorophenol	ND	10	ND

#30
Pg 156
33

For EnviroTest Laboratories, Inc.

Ronald A. Bower
President

/25/88

[illegible]

[illegible]

LAB # 82529-003

Client: Ramapo Landfill   Smpl Location: Well #4

Smpl Coll'd: 4/6/88   Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
1) Acenaphthene	ND	10	ND
2) Acenaphthylene	ND	10	ND
3) Anthracene	ND	10	ND
4) Benzidine	ND	10	ND
5) Benzo(a)Anthracene	ND	10	ND
6) Benzo(a)Pyrene	ND	10	ND
7) Benzo(b)Fluoranthene	ND	10	ND
8) Benzo(g,h,i)Perylene	ND	10	ND
9) Benzo(k)Fluoranthene	ND	10	ND
10) Bis(2-Chloroethoxy)Methane	ND	10	ND
11) Bis(2-Chloroethyl)Ether	ND	10	ND
12) Bis(2-Chloroisopropyl)Ether	ND	10	ND
13) Bis(2-Ethylhexyl)phthalate	65	10	ND
14) 4-Bromophenylphenylether	ND	10	ND
15) Butyl Benzyl Phthalate	ND	10	ND
16) 2-Chloronaphthalene	ND	10	ND
17) 4-Chlorophenylphenylether	ND	10	ND
18) Chrysene	ND	10	ND
19) Dibenzo(a,h)Anthracene	ND	10	ND
20) 1,2-Dichlorobenzene	ND	10	ND
21) 1,3-Dichlorobenzene	ND	10	ND
22) 1,4-Dichlorobenzene	ND	10	ND
23) 3,3'-Dichlorobenzidine	ND	10	ND
24) Diethyl Phthalate	ND	10	ND
25) Dimethyl Phthalate	ND	10	ND
26) Di-N-Butyl Phthalate	ND	10	ND
27) 2,4-Dinitrotoluene	ND	10	ND
28) 2,6-Dinitrotoluene	ND	10	ND
29) Di-N-Octyl Phthalate	ND	10	ND
30) 1,2-Diphenylhydrazine	ND	10	ND
31) Fluoranthene	ND	10	ND

#30
pg 16 of
33

EnviroTest Laboratories Inc.

LAB # 63559-002

Client: Ramapo Landfill

Sol Location: Well #4

Sol Coll'd: 4/6/88

Sample Rec'd: 4/6/88

EPA Method 625 Base/Neutral Extractables GC/MS

COMPOUND	RESULTS Sample Concen. ug/l	MDL ug/l	BLANK Conc. ug/l
32) Fluorene	ND	10	ND
33) Hexachlorobenzene	ND	10	ND
34) Hexachlorobutadiene	ND	10	ND
35) Hexachlorocyclopentadiene	ND	10	ND
36) Hexachloroethane	ND	10	ND
37) Indeno(1,2,3-cd) Pyrene	ND	10	ND
38) Isophorone	ND	10	ND
39) Naphthalene	ND	10	ND
40) Nitrobenzene	ND	10	ND
41) N-Nitrosodimethylamine	ND	10	ND
42) N-Nitrosodi-n-Propylene	ND	10	ND
43) Ni-Nitrosodiphenylamine	ND	10	ND
44) Phenanthrene	ND	10	ND
45) Pyrene	ND	10	ND
46) 1,2,4-Trichlorobenzene	ND	10	ND

#30 PG 17 of

For EnviroTest Laboratories, Inc.

Ronald A. Bayer
President

4/25/88

[illegible]

[illegible]

Client: Ramapo Landfill

Sol Location: well #4

Sol Coll d: 4/6/88

Sample Rec'd: [illegible]/6/88

EPA Method 608 Pesticide/PCB GC/EC

		RESULTS		BLANK
	COMPOUND	Sample Concen. ug/l	MDL ug/l	Conc.
1)	Alpha-BHC	ND	0.05	ND
2)	Beta-BHC	ND	0.05	ND
3)	Delta-BHC	ND	0.05	ND
4)	Lindane	ND	0.05	ND
5)	Heptachlor	ND	0.05	ND
6)	Aldrin	ND	0.05	ND
7)	Heptachlor epoxide	ND	0.05	ND
8)	Endosulfan I	ND	0.05	ND
9)	Dieldrin	ND	0.05	ND
10)	4.4'-DDE	ND	0.05	ND
11)	Endrin	ND	0.05	ND
12)	Endosulfan II	ND	0.05	ND
13)	4.4'-DDD	ND	0.05	ND
14)	Endosulfan sulfate	ND	0.05	ND
15)	4.4'-DDT	ND	0.05	ND
16)	Methoxychlor	ND	0.5	ND
17)	Endrin Ketone	ND	0.1	ND
18)	Chlordane	ND	0.5	ND
19)	Toxaphene	ND	0.5	ND
20)	PCB Aroclor 1016	ND	0.1	ND
21)	PCB Aroclor 1221	ND	0.1	ND
22)	PCB Aroclor 1232	ND	0.1	ND
23)	PCB Aroclor 1242	ND	0.1	ND
24)	PCB Aroclor 1248	ND	0.1	ND
25)	PCB Aroclor 1254	ND	0.1	ND
26)	PCB Aroclor 1260	ND	0.1	ND

#30
pg 1809

For EnviroTest Laboratories, Inc.

Ronald A. Baker
President

4/25/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-004 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closec
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SFL LOCATION: 2A

REPORT TO: same
BILL TO:

T COLI:
F COLI:
SPC :
F :
[illegible] :
NO2 :
T-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 600
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Cclor :
Odor :
Turb :
pH : 7.1
LI :
Cond : 650 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 3.4
Pb :
Mg :
Mn : 3.3
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 190
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 5.5

#32
Pg 191

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-005 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: [illegible]
NAME: (T) Ramapo
AME:
TREET:
CITY: STATE: ZIP:
SPL LOCATION: 4A

EPORT TO: same
BILL TO:

COLI:
COLI:
SPC :
:
O3 :
NO2 :
T-PO4 :
-PO4 :
[illegible] :
MBAS :
iO2 :
2S :
NH3-C :

SS :
S :
VS :
DS : 590
S :
% SOL :
[illegible] & O :
[illegible] :
Sb :
As :
a :
e :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.5
LI :
Cond : 630
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 13
Pb :
Mg :
Mn : 1.2
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 140
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 30

#30
Pg 20 of 33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Saver
Laboratory Director [illegible]/15/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-006 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
TREET: CITY: STATE: ZIP:
SPL LOCATION: 7

EPORT TO: same
BILL TO: same

COLI:		Cr+6 :		COD :	
COLI:		Phenol:		HARD-T :	
SPC :		CN :		Ca Hard:	
:		B :		SO3 :	
NO3 :		Sr :		Cl :	320
NO2 :		Color :		Alk :	
T-PO4 :		Odor :		BOD-Inf:	
O-PO4 :		Turb :		BOD-Eff:	
SO4 :		pH :	6.9	BOD-S :	
MBAS :		LI :		TSS-Inf:	
SiO2 :		Cond :	1700	TSS-Eff:	
H2S :		NH3-T :		MLSS :	
NH3-C :		TKN :		MLVSS :	
SS :		Ca :		K :	
TS :		Cr :		Se :	
VS :		Co :		Ag :	
TDS :	1400	Cu :		Na :	
SS :		Au :		Tl :	
% SOL :		Fe :	23	Sn :	
G & O :		Pb :		Ti :	
Al :		Mg :		V :	
Sb :		Mn :	13	Zn :	
As :		Hg :		THM :	
Ba :		Mo :		TOC :	29
Be :		Ni :			
Cd :		Pd :			

#30
PG 21 of
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Baver
Laboratory Director 5/16/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-007 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo
TREET:
SPL LOCATION: 8
FNAME:
CITY: STATE: ZIP:

EPORT TO: same
ILL TO: same

COLI:
COLI:
SPC :
:
O3 :
NO2 :
T-PO4 :
-PO4 :
SO4 :
MBAS :
iO2 :
2S :
NH3-C :

SS :
TS :
VS :
DS : 190
S :
% SOL :
& O :
l :
Sb :
s :
a :
e :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.4
LI :
Cond : 200
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 1.6
Pb :
Mg :
Mn : 0.4
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 9.6
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 1.1

#30 Pg 2209 33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/16/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-008 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SPL LOCATION: 8A

REPORT TO: same
BILL TO: same

T COLI:
F COLI:
SPC :
F :
NO_3 :
NO_2 :
T-PO_4 :
O-PO_4 :
SO_4 :
MBAS :
SiO_2 :
H_2S :
NH_3-C :

VSS :
TS :
VS :
TDS : 200
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.2
LI :
Cond : 190 umhos
NH_3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 4.4
Pb :
Mg :
Mn : 0.3
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO_3 :
Cl : 9.6
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 3.0

#30
Pg 230
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest
Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-009 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
PL LOCATION: 10

REPORT TO: same
ILL TO: same

COLI:
F COLI:
PC :
:
NO3 :
O2 :
-PO4 :
O-PO4 :
O4 :
BAS :
iO2 :
H2S :
H3-C :

VSS :
S :
S :
TDS : 180
SS :
SOL :
& O :
Al :
b :
s :
Ba :
e :
d :

Cr+6 :
Phenol :
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.4
LI :
Cond : 180 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 11
Pb :
Mg :
Mn : 2.5
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard :
SO3 :
Cl : 24
Alk :
BOD-Inf :
BOD-Eff :
BOD-S :
TSS-Inf :
TSS-Eff :
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 1.6

#30
Pg 24 of 33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-010 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
PL LOCATION: 10A

REPORT TO: same
BILL TO: same

COLI :
F COLI :
SPC :
:
NO3 :
NO2 :
-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 180
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol :
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.3
LI :
Cond : 190 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 56
Pb :
Mg :
Mn : 3.2
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard :
SO3 :
Cl : 28
Alk :
BOD-Inf :
BOD-Eff :
BOD-S :
TSS-Inf :
TSS-Eff :
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 12

P6250
33
2/12

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

New York State Department of Health Approved

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

.AB#: 63559-011 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
_NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
;PL LOCATION: 11A

REPORT TO: same
ILL TO: same

COLI :
F COLI :
PC :
:
NO3 :
02 :
-PO4 :
O-PO4 :
SO4 :
BAS :
SiO2 :
H2S :
H3-C :

VSS :
TS :
S :
TDS : 1800
SS :
% SOL :
G & O :
Al :
Sb :
s :
Ba :
Be :
Cd :

Cr+6 :
Phenol :
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.7
LI :
Cond : 2000 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 0.6
Pb :
Mg :
Mn : 6.8
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard :
SO3 :
Cl : 440
Alk :
BOD-Inf :
BOD-Eff :
BOD-S :
TSS-Inf :
TSS-Eff :
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 3.7

#3C
p. 269
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-012 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS [illegible]ed
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
PL LOCATION: 11B

REPORT TO: same
ILL TO: same

T COLI:
F COLI:
PC :
F :
NO3 :
NO2 :
-PO4 :
O-PO4 :
SO4 :
IBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 890
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.8
LI :
Cond : 1100 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 42
Pb :
Mg :
Mn : 4.9
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 190
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 14

#30
Pg 274
33

Remarks: All results in mg/l unless otherwise indicated.

RAB
Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest
Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-013 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
FL LOCATION: 12

REPORT TO: same
BILL TO: same

. COLI:		Cr+6 :		COD :	
F COLI:		Phenol:		HARD-T :	
'C :		CN :		Ca Hard:	
:		B :		SO3 :	
NO3 :		Br :		Cl :	47
NO2 :		Color :		Alk :	
-PO4 :		Odor :		BOD-Inf:	
u-PO4 :		Turb :		BOD-Eff:	
SO4 :		pH :	6.8	BOD-S :	
BAS :		LI :		TSS-Inf:	
iO2 :		Cond :	590 umhos	TSS-Eff:	
H2S :		NH3-T :		MLSS :	
H3-C :		TKN :		MLVSS :	
VSS :		Ca :		K :	
TS :		Cr :		Se :	
S :		Co :		Ag :	
DS :	620	Cu :		Na :	
SS :		Au :		Tl :	
SOL :		Fe :	29	Sn :	
& O :		Pb :		Ti :	
Al :		Mg :		V :	
b :		Mn :	14	Zn :	
s :		Hg :		THM :	
Ba :		Mo :		TOC :	11
Re :		Ni :			
d :		Pd :			

#20
76289
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

New York State Department of Health Approved

EnviroTest
Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-014 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closec
LNAME: (T) Ramapo
FNAME:
STREET:
CITY: STATE: ZIP:
PL LOCATION: 113

REPORT TO: same
ILL TO: same

T COLI:
F COLI:
SPC :
F :
NO3 :
NO2 :
T-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 470
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 8.2
LI :
Cond : 560 unhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 1.3
Pb :
Mg :
Mn : 0.1
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 87
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 2.7

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Pg 29 of
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

New York State Department of Health Approved

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

AB#: 63559-015 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
NAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SPL LOCATION: 114

REPORT TO: same
BILL TO: same

T COLI:
F COLI:
SPC :
F :
NO3 :
NO2 :
T-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.9
LI :
Cond : 140 umhos
NH3-T :
TKN :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 6.9
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

#32
PL 309
33

VSS :
TS :
VS :
TDS : 140
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 13
Pb :
Mg :
Mn : 0.5
Hg :
Mo :
Ni :
Pd :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 1.5

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-016 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SPL LOCATION: 16

REPORT TO: same
BILL TO: same

T COLI:
F COLI:
SPC :
F :
NO3 :
NO2 :
T-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 1100
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 6.7
LI :
Cond : 1300 umhos
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 51
Pb :
Mg :
Mn : 4.3
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 370
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 29

#30
Pg 31 of
33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/2/88

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-017 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
LNAME: (T) Ramapo FNAME:
STREET: CITY: STATE: ZIP:
SPL LOCATION: 116

REPORT TO: same
BILL TO: same

T COLI:
F COLI:
SPC :
F :
NO3 :
NO2 :
T-PO4 :
O-PO4 :
SO4 :
MBAS :
SiO2 :
H2S :
NH3-C :

VSS :
TS :
VS :
TDS : 160
SS :
% SOL :
G & O :
Al :
Sb :
As :
Ba :
Be :
Cd :

Cr+6 :
Phenol:
CN :
B :
Br :
Color :
Odor :
Turb :
pH : 7.50
LI :
Cond : 170
NH3-T :
TKN :

Ca :
Cr :
Co :
Cu :
Au :
Fe : 0.4
Pb :
Mg :
Mn : <0.05
Hg :
Mo :
Ni :
Pd :

COD :
HARD-T :
Ca Hard:
SO3 :
Cl : 32
Alk :
BOD-Inf:
BOD-Eff:
BOD-S :
TSS-Inf:
TSS-Eff:
MLSS :
MLVSS :

K :
Se :
Ag :
Na :
Tl :
Sn :
Ti :
V :
Zn :
THM :
TOC : 1.0

#30 Pg 32 of 33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Bayer
Laboratory Director 5/16/88

New York State Department of Health Approved

EnviroTest Laboratories Inc.

315 Fullerton Avenue
Newburgh, NY 12550
(914) 562-0890

LAB#: 63559-018 DATE REC'D: 88/04/06 DATE COLL'D: 88/04/06 STATUS: Closed
LNAME: (T) Ramapo FNAME:
TREET: CITY: STATE: ZIP:
PL LOCATION: 14

EPORT TO: same
ILL TO: same

T COLI:		Cr+6 :		COD :	
COLI:		Phenol:		HARD-T :	
SPC :		CN :		Ca Hard:	
F :		B :		SO3 :	
O3 :		Br :		Cl :	400
.O2 :		Color :		Alk :	
T-PO4 :		Odor :		BOD-Inf:	
-PO4 :		Turb :		BOD-Eff:	
O4 :		pH :	7.3	BOD-S :	
MBAS :		LI :		TSS-Inf:	
SiO2 :		Cond :	1600	TSS-Eff:	
OS :		NH3-T :		MLSS :	
NH3-O :		TKN :		MLVSS :	
SS :		Ca :		K :	
S :		Cr :		Se :	
VS :		Co :		Ag :	
TDS :	1400	Cu :		Na :	
S :		Au :		Tl :	
% SOL :		Fe :	41	Sn :	
R & O :		Pb :		Ti :	
l :		Mg :		V :	
Sb :		Mn :	6.4	Zn :	0.13
As :		Hg :		THM :	
s :		Mo :		TOC :	
e :		Ni :			
Cu :		Pd :			

#30
PG 33 of 33

Remarks: All results in mg/l unless otherwise indicated.

Ronald A. Baver
Laboratory Director 4/25/88

BENDER HYGIENIC LABORATORY

9 Samaritan Drive
Albany, N.Y. 12208
(518) 472-9124

ENVIRONMENTAL LABORATORY ANALYTICAL RESULTS

#31
Pg 1 of 2

Customer: DUNN GEOSCIENCE CORPORATION -- JOHN URUSKY
Bender Sample # 71170 Collected: 7-25-88 Received: 7-26-88
Project: # 2406-1-617 (TOWN OF RAMAPO) Sample ID# DGC-6S

ANALYTE	Total Matrix	Dissolved Matrix
ANTIMONY	<0.060 mg\L	<0.060 mg/L
ARSENIC	<0.010 mg\L	<0.010 mg/L
BERYLLIUM	<0.002 mg\L	<0.002 mg/L
BARIUM	<0.10 mg\L	<0.10 mg/L
CADMIUM	<0.002 mg\L	<0.002 mg/L
CHROMIUM, TOT.	<0.010 mg\L	<0.010 mg/L
CHROMIUM, HEX.	N A	N A
COPPER	0.03 mg\L	<0.02 mg/L
LEAD	<0.005 mg\L	<0.005 mg/L
MERCURY	<0.0004 mg\L	<0.0004 mg/L
NICKEL	<0.04 mg\L	<0.04 mg/L
SELENIUM	<0.002 mg\L	<0.002 mg/L
SILVER	<0.005 mg\L	<0.005 mg/L
THALLIUM	<0.010 mg\L	<0.010 mg/L
ZINC	0.02 mg\L	<0.02 mg/L
ALUMINUM	5.04 mg\L	<0.020 mg/L
IRON	7.55 mg\L	<0.05 mg/L
MANGANESE	0.16 mg\L	0.03 mg/L
AMMONIA-N	0.11 mg\L	-
NITRATE-N	0.2 mg\L	-
TOT. KJEL. N	0.11 mg\L	-
BIOL. OXY. DMD.	<2 mg\L	-
CHEM. OXY. DMD.	<5 mg\L	-
TOT. ORG. CARBON	1.3 mg\L	-
CYANIDE, TOT.	<0.010 mg\L	-
PHENOLS, TOT.	<0.005 mg\L	-
ALKALINITY, TOT.	7 mg\L	-
BORON	<0.10 mg\L	-
CALCIUM	6.2 mg\L	4.6 mg/L
CHLORIDE	<2 mg\L	-
HARDNESS, TOT. NON-CARBONATE	11 mg\L	-
HARDNESS, TOT. CARBONATE	7 mg\L	-
MAGNESIUM	2.49 mg\L	1.51 mg/L
POTASSIUM	1.90 mg\L	0.76 mg/L
SODIUM	3.6 mg\L	
SULFATE	20 mg\L	-
TOT. DISS. SOLIDS	54 mg\L	-
COLOR, UNITS	<5 mg\L	-
TURBIDITY, NTU	105 mg\L	-

Boron Analysis by ERCO Lab -- ELAP ID# 10141

William Ringler
William Ringler
Environmental Division

Date of Report: 8-22-88
NYSDOH ELAP ID# 10350

Sample Number
DGC-6S

Organics Analysis Data Sheet
(Page 1)

Laboratory Name: Enseco - Erco Laboratory

Case No: DUNN GEOSCIENCE

Lab Sample ID No: 0307-01

QC Report No: –

Sample Matrix: WATER

Contract No: –

Data Release Authorized By: VOA / ARL

Date Sample Received: 07-26-88

Volatile Compounds

Concentration: Low

Date Extracted/Prepared: 08-02-88

Date Analyzed: 08-02-88

Conc/Dil Factor: 1 pH: –

Percent Moisture: –

Percent Moisture (Decanted): –

#31
Pg 2of2

CAS Number		ug/L
74-87-3	Chloromethane	10 U
74-83-9	Bromomethane	10 U
75-01-4	Vinyl Chloride	10 U
75-00-3	Chloroethane	10 U
75-09-2	Methylene Chloride	5.2 B
67-64-1	Acetone	10 U
75-15-0	Carbon Disulfide	5 U
75-35-4	1,1-Dichloroethene	5 U
75-34-3	1,1-Dichloroethane	5 U
156-60-5	Trans-1,2-Dichloroethene	5 U
67-66-3	Chloroform	5 U
107-06-2	1,2-Dichloroethane	5 U
78-93-3	2-Butanone	10 U
71-55-6	1,1,1-Trichloroethane	5 U
56-23-5	Carbon Tetrachloride	5 U
108-05-4	Vinyl Acetate	10 U
75-27-4	Bromodichloromethane	5 U

CAS Number		ug/L
78-87-5	1,2-Dichloropropane	5 U
10061-02-6	Trans-1,3-Dichloropropene	5 U
79-01-6	Trichloroethene	5 U
124-48-1	Dibromochloromethane	5 U
79-00-5	1,1,2-Trichloroethane	5 U
71-43-2	Benzene	2.6 J
10061-01-5	cis-1,3-Dichloropropene	5 U
110-75-8	2-Chloroethylvinylether	10 U
75-25-2	Bromoform	5 U
108-10-1	4-Methyl-2-Pentanone	10 U
591-78-6	2-Hexanone	10 U
127-18-4	Tetrachloroethene	5 U
79-34-5	1,1,2,2-Tetrachloroethane	5 U
108-88-3	Toluene	5 U
108-90-7	Chlorobenzene	5 U
100-41-4	Ethylbenzene	5 U
100-42-5	Styrene	5 U
	Total Xylenes	5 U

Data Reporting Qualifiers

For reporting results to EPA, the following results qualifiers are used. Additional flags or footnotes explaining results are encouraged. However, the definition of each flag must be explicit.

Value	If the result is a value greater than or equal to the detection limit, report the value.
U	Indicates compound was analyzed for but not detected. Report the minimum detection limit for the sample with the U (e.g. 10U) based on necessary concentration/dilution actions. (This is not necessarily the instrument detection limit.) The footnote should read: U - Compound was analyzed for but not detected. The number is the minimum attainable detection limit for the sample
J	Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicated the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero. (e.g. 10J). If limit of detection is 10ug/l and a concentration of 3ug/l is calculated, report as 3J
C	This flag applies to pesticide parameters where the identification has been confirmed by GC/MS. Single component pesticides >= 10ng/ul in the final extract should be confirmed by GC/MS
B	This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
D	Coelution.
NA	Not Analyzed.
M	Compound exceeded the instrument calibration range.
NR	Not Required.
A	Matrix spike compound.

7

CLF: 11/14/85

Form I

Prepared by: ARL

10/85

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION
01 STATE 02 SITE NUMBER
NY D980640858

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

☐ A. SOLID
☐ B. POWDER, FINES
☐ C. SLUDGE
☐ D. OTHER ________ (Specify)
☐ E. SLURRY
☒ F. LIQUID
☐ G. GAS

02 WASTE QUANTITY AT SITE

(Measures of waste quantities must be independent)

TONS ____
CUBIC YARDS ____
NO. OF DRUMS 50

03 WASTE CHARACTERISTICS (Check all that apply)

☒ A. TOXIC
☐ B. CORROSIVE
☐ C. RADIOACTIVE
☒ D. PERSISTENT
☐ E. SOLUBLE
☐ F. INFECTIOUS
☐ G. FLAMMABLE
☐ H. IGNITABLE
☐ I. HIGHLY VOLATILE
☐ J. EXPLOSIVE
☐ K. REACTIVE
☐ L. INCOMPATIBLE
☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE			
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS	50	Drums	Liquid wastes with high concentrations of Cu, Pb, and Zn were found on site.

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IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Copper	7440-50-8	Drums	1	mg/L
MES	Lead	7439-92-1	Drums	320	mg/L
MES	Zinc	7440-66-6	Drums	15	mg/L
MES	Cadmium	7440-43-9	Unknown	15	ug/L
MES	Chromium	7440-47-3	Unknown	57	ug/L
MES	Iron	7439-89-6	Unknown	56600	ug/L
MES	Manganese	7439-96-5	Unknown	3940	ug/L

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (See specific references. e.g., state files, sample analysis, reports)

New York State Department of Environmental Conservation Files, Phase 1 Study Ramapo Land Company Site, EA Science and Technology.
U.S. EPA Contract Laboratory Program, Environmental Protection Systems and West Coast Analytical Service Inc.
Case No. 6812, Laboratory Analysis from NUS Region 2 FIT site inspection conducted on February 5, 1987.

ANALYTICAL DATA
Torne Mountain Sand and Gravel Company aka Ramapo Land Company
February 5, 1987
Case: #6812

VOLATILES

SAMPLE NUMBER TRAFFIC REPORT NUMBER MATRIX UNITS	NY62-GW1 BI548 aqueous ug/L	NY62-GW2 BI549 aqueous ug/L	NY62-GW3 BI550 aqueous ug/L	NY62-SW1 BI459 aqueous ug/L	NY62-SED1 BI546 sediment ug/kg	NY62-SW2 BI555 aqueous ug/L	NY62-SED2 BI547 sediment ug/kg	NY62-BL1 BI551 aqueous ug/L
Chloromethane								
Bromomethane								
Vinyl Chloride								
Chloroethane								
Methylene Chloride	Q	Q		Q	Q		Q	6
Acetone	Q B	Q B	Q B	Q B	Q B	Q B	Q B	
Carbon Disulfide								
1,1-Dichloroethene								
1,1-Dichloroethane								
Trans-1,2-Dichloroethene								
Chloroform								
1,2-Dichloroethane								
2-Butanone								
1,1,1-Trichloroethane								
Carbon Tetrachloride								
Vinyl Acetate								
Bromodichloromethane								
1,1,2,2-Tetrachloroethane								
1,2-Dichloropropane								
Trans-1,3-Dichloropropene								
Trichloroethene								
Dibromochloromethane								
1,1,2-Trichloroethane								
Benzene								
Cis-1,3-Dichloropropene								
2-Chloroethylvinylether								
Bromoform								
2-Hexanone								
4-Methyl-2-Pentanone								
Tetrachloroethene								
Toluene								
Chlorobenzene								
Ethylbenzene								
Styrene								
Total Xylenes								

#33
Pg 1 of
5

NOTES:
Blank space - compound analyzed for but not detected
Q - analysis did not pass EPA QA/QC requirements
J - compound present below the specified detection limit
B - compound found in laboratory blank as well as the sample, indicates possible/probable blank contamination

ANALYTICAL DATA
Torne Mountain Sand and Gravel Company aka Ramapo Land Company
February 5. 1987
Case: #6812

SEMI-VOLATILES

SAMPLE NUMBER	NY62-GW1	NY62-GW2	NY62-GW3	NY62-SW1	NY62-SED1	NY62-SW2	NY62-SED2	NY62-BL1
TRAFFIC REPORT NUMBER	BI548	BI549	BI550	BI459	BI546	BI555	BI547	BI551
MATRIX	aqueous	aqueous	aqueous	aqueous	sediment	aqueous	sediment	aqueous
UNITS	ug/L	ug/L	ug/L	ug/L	ug/kg	ug/L	ug/kg	ug/L
N-Nitrosodimethylamine								
Phenol								
Aniline								
Bis(2-Chloroethyl)Ether								
2-Chlorophenol								
1,3-Dichlorobenzene								
1,4-Dichlorobenzene								
Benzyl Alcohol								
1,2-Dichlorobenzene								
2-Methylphenol								
Bis(2-Chloroisopropyl)Ether								
4-Methylphenol								
N-Nitroso-Di-n-Propylamine								
Hexachloroethane								
Nitrobenzene								
Isophorone								
2-Nitrophenol								
2,4-Dimethylphenol								
Benzoic Acid					69.J		110.J	
Bis(2-Chloroethoxy)Methane								
2,4-Dichlorophenol								
1,2,4-Trichlorobenzene								
Naphthalene								
4-Chloroaniline								
Hexachlorobutadiene								
4-Chloro-3-Methylphenol								
2-Methylnaphthalene								
Hexachlorocyclopentadiene								
2,4,6-Trichlorophenol								
2,4,5-Trichlorophenol								
2-Chloronaphthalene								
2-Nitroaniline								
Dimethyl Phthalate								
Acenaphthylene								
3-Nitroaniline								
Acenaphthene								
2,4-Dinitrophenol								
4-Nitrophenol								
Dibenzofuran								
2,4-Dinitrotoluene								
2,6-Dinitrotoluene								
Diethylphthalate							48.J	
4-Chlorophenylphenyl ether								
Fluorene								

#33
PG 2 of
5

ANALYTICAL DATA
Torne Mountain Sand and Gravel Company aka Ramapo Land Company
February 5. 1987
Case: #6812

SEMI-VOLATILES

SAMPLE NUMBER	NY62-GW1	NY62-GW2	NY62-GW3	NY62-SW1	NY62-SED1	NY62-SW2	NY62-SED2	NY62-BL1
TRAFFIC REPORT NUMBER	BI548	BI549	BI550	BI459	BI546	BI555	BI547	BI551
MATRIX	aqueous	aqueous	aqueous	aqueous	sediment	aqueous	sediment	aqueous
UNITS	ug/L	ug/L	ug/L	ug/L	ug/kg	ug/L	ug/kg	ug/L
4-Nitroaniline								
4,6-Dinitro-2-Methylphenol								
N-Nitrosodiphenylamine								
4-Bromophenylphenyl ether								
Hexachlorobenzene								
Pentachlorophenol					220.J		280.J	
Phenanthrene					120.J		57.J	
Anthracene								
Di-n-Butylphthalate	1.J	1.J				1.J		
Fluoranthene					160.J		130.J	
Pyrene					140.J		140.J	
Butylbenzylphthalate								
3,3'-Dichlorobenzidine								
Benzo(a)Anthracene					51.J			
Bis(2-Ethylhexyl)Phthalate	1.J	1.J			Q B		Q B	
Chrysene					55.J		49.J	
Di-n-Octyl Phthalate								
Benzo(b)Fluoranthene					110.J		87.J	
Benzo(k)Fluoranthene								
Benzo(a)Pyrene					64.J		51.J	
Indeno(1,2,3-cd)Pyrene								
Dibenzo(a,h)Anthracene								
Benzo(ghi)Perylene								

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Pg 309
5

NOTES:

Blank space - compound analyzed for but not detected
Q - analysis did not pass EPA QA/QC requirements
J - compound present below the specified detection limit
B - compound found in laboratory blank as well as the sample, indicates possible/probable blank contamination

ANALYTICAL DATA
Torne Mountain Sand and Gravel Company aka Ramapo Land Company
February 5, 1987
Case: #6812

PESTICIDES/PCBs

SAMPLE NUMBER	NY62-SW1	NY62-GW2	NY62-GW3	NY62-SW1	NY62-SED1	NY62-SW2	NY62-SED2	NY62-BL1
TRAFFIC REPORT NUMBER	B1548	B1549	B1550	B1459	B1546	B1555	B1547	B1551
MATRIX	aqueous	aqueous	aqueous	aqueous	sediment	aqueous	sediment	aqueous
UNITS	ug/L	ug/L	ug/L	ug/L	ug/kg	ug/L	ug/kg	ug/L
Alpha-BHC								
Beta-BHC								
Delta-BHC								
Gamma-BHC (Lindane)								
Heptachlor								
Aldrin								
Heptachlor Epoxide								
Endosulfan I								
Dieldrin								
4,4'-DDE								
Endrin								
Endosulfan II								
4,4'-DDD								
Endosulfan sulfate								
Endrin Aldehyde								
4,4'-DDT								
Methoxychlor								
Endrin Ketone								
Chlordane								
Toxaphene								
Aroclor-1016								
Aroclor-1221								
Aroclor-1232								
Aroclor-1242								
Aroclor-1248								
Aroclor-1254								
Aroclor-1260								

NOTES:
Blank space - compound analyzed for but not detected
Q - analysis did not pass EPA QA/QC requirements
J - compound present below the specified detection limit
B - compound found in laboratory blank as well as the sample, indicates possible/probable blank contamination

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ANALYTICAL DATA
Torne Mountain Sand and Gravel Company aka Ramapo Land Company
February 5, 1987
Case: #6812

INORGANICS

SAMPLE NUMBER	NY62-GW1	NY62-GW2	NY62-GW3	NY62-SW1	NY62-SED1	NY62-SW2	NY62-SED2	NY62-BL1
TRAFFIC REPORT NUMBER	MBI729	MBI931	MBI770	MBI934	MBI938	MBI936	MBI939	MBI933
MATRIX	aqueous	aqueous	aqueous	aqueous	sediment	aqueous	sediment	aqueous
UNITS	ug/L	ug/L	ug/L	ug/L	mg/kg	ug/L	mg/kg	ug/L
Aluminum	18500	27800	41700	2170	5580	[130]	6150	[71]
Antimony							7.2E	
Arsenic							[1.9]	
Barium	[130]	[160]	270		[30]		[25]	
Beryllium	[1.0]	[2.3]	[1.9]		[0.4]		[0.42]	
Cadmium	11	15	9.5		3.0		5.4	
Calcium	35400	25300	94900	15200	4870	18500	1330	
Chromium	57	54	45		15		20	
Cobalt	[15]	[19]	[20]		[8.0]		[6.0]	
Copper	220	88	76	[13]	12		33	
Iron	56600	50000	54700	2800	13800	Q	26100	[62]
Lead	140	230	Q	Q	10		15	
Magnesium	17100	15600	27700	[4490]	3780	[4360]	2840	
Manganese	1790	3940	1630	310	260	48	410	
Mercury	0.3							
Nickel	43	45	[40]		[6.0]		12	
Potassium	[3790]	[3030]	5040	[1490]	[710]		[450]	
Selenium								
Silver	Q	Q	Q	Q		Q		Q
Sodium	14900	10700	80200	29800		44500		
Thallium								
Vanadium	[48]	120	64		16		25	
Zinc	120E	140E	130E	Q	37	Q	48	Q

NOTES:
Blank space - compound analyzed for but not detected
Q - analysis did not pass EPA QA/QC requirements
B - compound found in laboratory blank as well as the sample, indicates possible/probable blank contamination
[] - compound present above the instrument detection limit, but below specified detection limits
E - indicates a value estimated or not reported due to the presence of interference

S
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#33

SW

Spring Valley Water Company

August 2, 1991

REC'D
URS CONSULT
AUG 5 1991
JOB # 35202

#34
Pg 1 of 12

Mr. James Lanzo
Project Manager
URS Consultants, Inc.
282 Delaware Ave.
Buffalo, NY 14202-1805

Dear Mr. Lanzo:

Attached, as per your letter dated July 12, 1991, is water quality information regarding Spring Valley Water Company Wells 94, 95 and 96.

If you have any questions, please feel free to contact me at 914-623-1500.

Sincerely,

Jean M. Matteo
Manager-
Environmental Resources

JMM:jc
Enc.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
200 ELM STREET,
ORADELL, NJ 07649

ANALYTICAL SUMMARY

#34 Pg 2 of 12

Lab Number ... 701278

Sample Identification ... Spring Valley Well 94-Ramapo Valley Well Field

Collection Date ... 7/12/88 Collector ... ML

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pH	6.7	Color (CU)	3
Turbidity (NTU)	0.5 1	Chlorine, Free	ND
		Total	ND
Temperature (F)	62	Fluoride	ND
Alkalinity, $CaCO_3$	42		
Carbon Dioxide, Free	17	Solids, Suspended	ND
Chloride	57	Volatile	78
Hardness, $CaCO_3$	80	Total	242
Calcium, Ca	24		
Magnesium, Mg	5	Conductivity	
Potassium, K	1	(Micromhos/cm)	357
Silica, SiO_2	--		
Sodium, Na	29	Dissolved Oxygen	--
Sulfate, SO_4	18		
Ammonia, Free, N	0.02	M.B.A.S.	ND
Nitrite, N	ND	Phosphate o-P	0.04
Nitrate, N	0.90 10	t-P	0.04
Aluminum, Al	0.05	Lead, Pb	ND
Arsenic, As	ND	Manganese, Mn	ND
Barium, Ba	ND	Mercury, Hg	ND
Cadmium, Cd	ND	Nickel, Ni	ND
Chromium, Cr	ND	Selenium, Se	ND
Copper, Cu	ND	Silver, Ag	ND
Iron, Fe	ND	Zinc, Zn	ND

Total Coliform Organisms, as MPN index per 100mL ... ND

Louis A. Briganti
Chief Chemist

Results are expressed in mg/L, unless otherwise stated.
Analyses are performed in accordance with the latest edition of "Standard Methods for the examination of Water and Wastewater" and/or USEPA approved methodology.
The nomenclature **"ND"** represents analytes that are not detected, or analytical detection limits as expressed within **Appendix A.**

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES

Louis R. Briganti
Chief Chemist

200 Elm Street
Oradell, N.J. 07649

VOLATILE ORGANIC ANALYSIS

Lab Number ... 702149
Sample Identification ... SV WELL #94
Comments ...
Collection Date ... 12/12/88
Collector ... SS
Analysis Date ... 12/19/88
Analyst ... **Carol R. Flach, Supervisor Chemist**

#34
PG37
12

CONTAMINANT	ppb	CONTAMINANT	ppb
BENZENE	ND	2,2-DICHLOROPROPANE	ND
BROMOBENZENE	ND	1,1-DICHLOROPROPENE	ND
BROMOCHLOROMETHANE	ND	cis-1,3-DICHLOROPROPENE	ND
BROMODICHLOROMETHANE	ND	trans-1,3-DICHLOROPROPENE	ND
BROMOFORM	ND	ETHYL BENZENE	ND
BROMOMETHANE	ND	HEXACHLOROBUTADIENE	ND
n-BUTYLBENZENE	ND	ISOPROPYL BENZENE	ND
sec-BUTYLBENZENE	ND	p-ISOPROPYLTOLUENE	ND
tert-BUTYLBENZENE	ND	METHYLENE CHLORIDE	ND
CARBON TETRACHLORIDE	ND	NAPHTHALENE	ND
CHLOROBENZENE	ND	n-PROPYL BENZENE	ND
CHLOROETHANE	ND	STYRENE	ND
CHLOROFORM	ND	1,1,1,2-TETRACHLOROETHANE	ND
CHLOROMETHANE	ND	1,1,2,2-TETRACHLOROETHANE	ND
2-CHLOROTOLUENE	ND	TETRACHLOROETHENE	ND
4-CHLOROTOLUENE	ND	TOLUENE	ND
DIBROMOCHLOROMETHANE	ND	1,2,3-TRICHLOROBENZENE	ND
DIBROMOMETHANE	ND	1,2,4-TRICHLOROBENZENE	ND
1,2-DICHLOROBENZENE	ND	1,1,1-TRICHLOROETHANE	ND
1,3-DICHLOROBENZENE	ND	1,1,2-TRICHLOROETHANE	ND
1,4-DICHLOROBENZENE	ND	TRICHLOROETHENE	ND
DICHLORODIFLUOROMETHANE	ND	TRICHLOROFLUOROMETHANE	ND
1,1-DICHLOROETHANE	ND	1,2,3-TRICHLOROPROPANE	ND
1,2-DICHLOROETHANE	ND	1,2,4-TRIMETHYLBENZENE	ND
1,1-DICHLOROETHENE	ND	1,3,5-TRIMETHYLBENZENE	ND
cis-1,2-DICHLOROETHENE	ND	VINYL CHLORIDE	ND
trans-1,2-DICHLOROETHENE	ND	m-XYLENE	ND
1,2-DICHLOROPROPANE	ND	o-XYLENE	ND
1,3-DICHLOROPROPANE	ND	p-XYLENE	ND

The nomenclature "**ND**" represents contaminants that are not detected, or an analytical detection limit of **0.5 ppb**.

Analyses are performed in accordance with USEPA approved methodology : USEPA Method **502.2**: "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water". Sept., 1986, EMSL, USEPA, Cincinnati, Ohio.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
200 ELM STREET
ORADELL, NJ 07649

EPA METHOD 504 ANALYSIS

REPORT DATE: 12/29/86
SAMPLE ID : SV WELL #34

SAMPLE # : 701278
COLLECTED [illegible]
ANALYZED [illegible]

#34
Pg 4 of 12

MICROEXTRACTABLES EPA Method 504	RESULTS ppb
1,2-Dibromoethane (EDB)	02
1,2-Dibromo-3-Chloropropane (DBCP	02

Kwc

Keith Cartnick / Supervisor-Chemist

Analyses are performed in accordance with USEPA approved methodology: EPA Method 504, EDB and DBCP in Water by Microextraction and Gas Chromatography, 1985, Ed. Rev. 1986.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
200 ELM STREET,
ORADELL, NJ 07649

ANALYTICAL SUMMARY

#34
Pg 5 of 12

Lab Number ... 70477
Sample Identification ... Spring Valley Well 95-Ramapo Valley Well Field
Collection Date ... 3/22/88 Collector ... AR

---

pH	7.0	Color (CU)	4
Turbidity (NTU)	0.4	Chlorine, Free	ND
		Total	ND
Temperature (F)	41	Fluoride	--
Alkalinity, $CaCO_3$	42		
Carbon Dioxide, Free	7	Solids, Suspended	ND
Chloride	92	Volatile	6
Hardness, $CaCO_3$	76	Total	126
Calcium, Ca	18		
Magnesium, Mg	7	Conductivity	
Potassium, K	--	(Micromhos/cm)	300
Silica, SiO_2	--		
Sodium, Na	--	Dissolved Oxygen	--
Sulfate, SO_4	10		
Ammonia, Free, N	0.02	M.B.A.S.	--
Nitrite, N	ND	Phosphate, o-P	ND
Nitrate, N	0.76	t-P	0.05
Aluminum, Al	0.07	Lead, Pb	--
Arsenic, As	--	Manganese, Mn	0.21
Barium, Ba	--	Mercury, Hg	--
Cadmium, Cd	--	Nickel, Ni	--
Chromium, Cr	--	Selenium, Se	--
Copper, Cu	0.01	Silver, Ag	--
Iron, Fe	0.07	Zinc, Zn	0.02

Total Coliform Organisms, as MPN Index per 100mL ... ND

L. A. B

Louis A. Briganti
Chief Chemist

Results are expressed in mg/L, unless otherwise stated.
Analyses are performed in accordance with the latest edition of "Standard Methods for the examination of Water and Wastewater" and/or USEPA approved methodology.
The nomenclature "**ND**" represents analytes that are not detected, or analytical detection limits as expressed within **Appendix A**.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES

Louis A. Briganti
Chief Chemist

200 Elm Street
Oradell, N.J. 07649

VOLATILE ORGANIC ANALYSIS

#34
PG 6 of 12

Lab Number ... 701654
Sample Identification ... SV WELL #95
Comments ...
Collection Date ... 10/11/88
Analysis Date ... 10/13/88
Collector ... SS
Analyst ... **Carol R. Flach, Supervisor Chemist**

CONTAMINANT	ppb	CONTAMINANT	ppb
BENZENE	ND	2,2-DICHLOROPROPANE	ND
BROMOBENZENE	ND	1,1-DICHLOROPROPENE	ND
BROMOCHLOROMETHANE	ND	cis-1,3-DICHLOROPROPENE	ND
BROMODICHLOROMETHANE	ND	trans-1,3-DICHLOROPROPENE	ND
BROMOFORM	ND	ETHYL BENZENE	ND
BROMOMETHANE	ND	HEXACHLOROBUTADIENE	ND
n-BUTYLBENZENE	ND	ISOPROPYL BENZENE	ND
sec-BUTYLBENZENE	ND	p-ISOPROPYLTOLUENE	ND
tert-BUTYLBENZENE	ND	METHYLENE CHLORIDE	ND
CARBON TETRACHLORIDE	ND	NAPHTHALENE	ND
CHLOROBENZENE	ND	n-PROPYL BENZENE	ND
CHLOROETHANE	ND	STYRENE	ND
CHLOROFORM	ND	1,1,1,2-TETRACHLOROETHANE	ND
CHLOROMETHANE	ND	1,1,2,2-TETRACHLOROETHANE	ND
2-CHLOROTOLUENE	ND	TETRACHLOROETHENE	ND
4-CHLOROTOLUENE	ND	TOLUENE	ND
DIBROMOCHLOROMETHANE	ND	1,2,3-TRICHLOROBENZENE	ND
DIBROMOMETHANE	ND	1,2,4-TRICHLOROBENZENE	ND
1,2-DICHLOROBENZENE	ND	1,1,1-TRICHLOROETHANE	ND
1,3-DICHLOROBENZENE	ND	1,1,2-TRICHLOROETHANE	ND
1,4-DICHLOROBENZENE	ND	TRICHLOROETHENE	ND
DICHLORODIFLUOROMETHANE	ND	TRICHLOROFLUOROMETHANE	ND
1,1-DICHLOROETHANE	ND	1,2,3-TRICHLOROPROPANE	ND
1,2-DICHLOROETHANE	ND	1,2,4-TRIMETHYLBENZENE	ND
1,1-DICHLOROETHENE	ND	1,3,5-TRIMETHYLBENZENE	ND
cis-1,2-DICHLOROETHENE	ND	VINYL CHLORIDE	ND
trans-1,2-DICHLOROETHENE	ND	m-XYLENE	ND
1,2-DICHLOROPROPANE	ND	o-XYLENE	ND
1,3-DICHLOROPROPANE	ND	p-XYLENE	ND

The nomenclature **"ND"** represents contaminants that are not detected, or an analytical detection limit of **0.5 ppb**.

Analyses are performed in accordance with USEPA approved methodology: USEPA Method **502.2**: "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water". Sept., 1986, EMSL, USEPA, Cincinnati, Ohio.

HACKENSACK WATER COMPANY
PESTICIDE / HERBICIDE ANALYSIS

Results expressed in ug/l.

#34 Pg 70/121

SAMPLE ID: S.V. WELL #95

CHLORINATED PESTICIDES STD Method 509A	Sample: #70296 collected: 3/24/87
Lindane	<0.05
Endrin	<0.05
Methoxyclor	<0.10
Toxaphene	<0.50

CHLOROPHENOXY ACID HERBICIDES STD Method 5096	
2,4-D	<0.10
Silvex	<0.05

Charles Appleby
Supervisor Chemist

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
200 ELM STREET
ORADELL, NJ 07649

EPA METHOD 504 ANALYSIS

REPORT DATE: 1/13/89
SAMPLE ID : SY WELL #95

SAMPLE # : 702153
COLLECTED: 12/12/88
ANALYZED : 12/16/88

#34
R 80
12

MICROEXTRACTABLES EPA Method 504	RESULTS (ppb)
1,2-Dibromoethane (EDB)	<.02
1,2-Dibromo-3-Chloropropane (DBCP)	<.02

Keith Cartnick / Supervisor-Chemist

Analyses are performed in accordance with USEPA approved methodology: EPA Method 504, EDB and DBCP in Water by Microextraction and Gas Chromatography, 1985, Ed. Rev. 1986.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
200 ELM STREET,
ORADELL, NJ 07649

ANALYTICAL SUMMARY

Lab Number ... 70478
Sample Identification ... Spring Valley Well 96-Ramapo Valley Well Field
Collection Date ... 3/22/88 Collector ... AR

#34
PL 96

pH	6.9	Color (CU)	3
Turbidity (NTU)	0.1	Chlorine, Free	ND
		Total	ND
Temperature (F)	45	Fluoride	--
Alkalinity, CaCO3	22		
Carbon Dioxide, Free	6	Solids, Suspended	ND
Chloride	17	Volatile	6
Hardness, CaCO3	70	Total	124
Calcium, Ca	17		
Magnesium, Mg	7	Conductivity	
Potassium, K	--	(Micromhos/cm)	288
Silica, SiO2	--		
Sodium, Na	--	Dissolved Oxygen	--
Sulfate, SO4	12		
Ammonia, Free, N	0.02	M.B.A.S.	--
Nitrite, N	ND	Phosphate, o-P	0.06
Nitrate, N	0.95	t-P	0.06
Aluminum, Al	0.07	Lead, Pb	--
Arsenic, As	--	Manganese, Mn	0.01
Barium, Ba	--	Mercury, Hg	--
Cadmium, Cd	--	Nickel, Ni	--
Chromium, Cr	--	Selenium, Se	--
Copper, Cu	0.01	Silver, Ag	--
Iron, Fe	0.01	Zinc, Zn	0.01

Total Coliform Organisms, as MPN Index per 100mL ... ND

Louis A. Briganti
Chief Chemist

Results are expressed in mg/L, unless otherwise stated.
Analyses are performed in accordance with the latest edition of "Standard Methods for the examination of Water and Wastewater" and/or USEPA approved methodology.
The nomenclature **"ND"** represents analytes that are not detected, or analytical detection limits as expressed within **Appendix A**.

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES

Louis A. Briganti
Chief Chemist

200 Elm Street
Oradell, N.J. 07649

VOLATILE ORGANIC ANALYSIS

#34
Pg 1 of 1

Lab Number ... 702150
Sample Identification ... SV WELL #96
Comments ...
Collection Date ... 12/12/88
Analysis Date ... 12/19/88
Collector ... SS
Analyst ... **Carol R. Flach, Supervisor Chemist**

CONTAMINANT	ppb	CONTAMINANT	ppb
BENZENE	ND	2,2-DICHLOROPROPANE	ND
BROMOBENZENE	ND	1,1-DICHLOROPROPENE	ND
BROMOCHLOROMETHANE	ND	cis-1,3-DICHLOROPROPENE	ND
BROMODICHLOROMETHANE	ND	trans-1,3-DICHLOROPROPENE	ND
BROMOFORM	ND	ETHYL BENZENE	ND
BROMOMETHANE	ND	HEXACHLOROBUTADIENE	ND
n-BUTYLBENZENE	ND	ISOPROPYL BENZENE	ND
sec-BUTYLBENZENE	ND	p-ISOPROPYLTOLUENE	ND
tert-BUTYLBENZENE	ND	METHYLENE CHLORIDE	ND
CARBON TETRACHLORIDE	ND	NAPHTHALENE	ND
CHLOROBENZENE	ND	n-PROPYL BENZENE	ND
CHLOROETHANE	ND	STYRENE	ND
CHLOROFORM	ND	1,1,1,2-TETRACHLOROETHANE	ND
CHLOROMETHANE	ND	1,1,2,2-TETRACHLOROETHANE	ND
2-CHLOROTOLUENE	ND	TETRACHLOROETHENE	ND
4-CHLOROTOLUENE	ND	TOLUENE	ND
DIBROMOCHLOROMETHANE	ND	1,2,3-TRICHLOROBENZENE	ND
DIBROMOMETHANE	ND	1,2,4-TRICHLOROBENZENE	ND
1,2-DICHLOROBENZENE	ND	1,1,1-TRICHLOROETHANE	ND
1,3-DICHLOROBENZENE	ND	1,1,2-TRICHLOROETHANE	ND
1,4-DICHLOROBENZENE	ND	TRICHLOROETHENE	ND
DICHLORODIFLUOROMETHANE	ND	TRICHLOROFLUOROMETHANE	ND
1,1-DICHLOROETHANE	ND	1,2,3-TRICHLOROPROPANE	ND
1,2-DICHLOROETHANE	ND	1,2,4-TRIMETHYLBENZENE	ND
1,1-DICHLOROETHENE	ND	1,3,5-TRIMETHYLBENZENE	ND
cis-1,2-DICHLOROETHENE	ND	VINYL CHLORIDE	ND
trans-1,2-DICHLOROETHENE	ND	m-XYLENE	ND
1,2-DICHLOROPROPANE	ND	o-XYLENE	ND
1,3-DICHLOROPROPANE	ND	p-XYLENE	ND

The nomenclature **"ND"** represents contaminants that are not detected, or an analytical detection limit of **0.5 ppb**.

Analyses are performed in accordance with USEPA approved methodology : USEPA Method **502.2**: "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water". Sept., 1986, EMSL, USEPA, Cincinnati, Ohio.

HACKENSACK WATER COMPANY
PESTICIDE / HERBICIDE ANALYSIS

Results expressed in ug/l.

SAMPLE ID: S.V. WELL #96

Sample: #70297
collected: 3/24/87

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#34

CHLORINATED PESTICIDES STD Method 509A	
Lindane	<0.05
Endrin	<0.05
Methoxychlor	<0.10
Toxaphene	<0.50

CHLOROPHENOXY ACID HERBICIDES STD Method 509B	
2,4-D	<0.10
Silvex	<0.05

Charles Appleby
Supervisor Chemist

HACKENSACK WATER COMPANY
ANALYTICAL LABORATORIES
900 ELM STREET
ORADELL, NJ 07649

EPA METHOD 504 ANALYSIS

REPORT DATE: 12/29/88
SAMPLE ID : SV WELL #96

SAMPLE #: [illegible]
COLLECTED: 7/11/88
ANALYZED: 7/15/88

#34
pg 12 of
12

MICROEXTRACTABLES EPA Method 504	RESULTS [illegible]
1,2-Dibromoethane (EDB)	<.02
1,2-Dibromo-3-Chloropropane (DBCP)	<.02

Kwc
Keith Cartnick / Supervisor-Chemist

Analyses are performed in accordance with USEPA approved methodology: EPA Method 504. EDB and DBCP in Water by Microextraction and Gas Chromatography, 1985, Ed. Rev. 1986.

5/1988

Table I
~~Current~~ United States Environmental Protection Agency Drinking Water Standards

Parameters[1]	U.S. EPA Primary MCL[2]	U.S. EPA Secondary MCL[3]
Physical factors		
Color, platinum standard	—	15
Odor, threshold number	—	3
Turbidity, JTU	1	—
pH, unit	—	6.5-8.5
Chemical factors		
Arsenic	0.1	—
Barium	1	—
Cadmium	0.01	—
Chloride	—	250
Chromium	0.05	—
Copper	—	1.0
Fluoride	1.4-2.4	—
Iron	—	0.3
Lead	0.05	—
Manganese	—	0.05
MBAS	—	0.6
Mercury	0.002	
Nitrate (as N)	10	—
Selenium	0.01	—
Silver	0.05	—
Sulfate	—	250
Total dissolved solids	—	500
Zinc	—	5
Corrosion and scaling factors		
Hardness	—	non-corrosive
Sodium	—	non-corrosive
Bacteriological factors		
Coliform (membrane filter)	1/100 mL	—
Radiologic factors		
Gross alpha activity	15 pCl/1	—
Gross beta activity	—	—
Radium 226 and 228	5 pCl/1	—
Strontium 90	—	—
Pesticides-Herbicides		
Chlorinated hydrocarbons		
Endrin	0.0005	—
Lindane	0.005	—
Methoxychlor	1.0	—
Toxaphene	0.005	—
Chlorophenoxy herbicides		
2, 4-D	0.02	—
2, 4, 5-TP (Silvex)	0.03	—
Total trihalomethane	0.1	—

Notes: 1. Units are in mg/L unless noted otherwise.
2. MCL = maximum contaminant level.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

Thomas C. Jorling
Commissioner

September 3, 1991

RECEIVED
CONSULTANTS
SEP 5 1991
JOB # 35207-VI-C

#35
Pg 1 of

Mr. Gene Ostertag
Senior Engineer
Town of Ramapo
Department of Public Works
Pioneer Avenue
Tallman, NY 10982

Dear Mr. Ostertag:

RE: Ramapo Landfill (Site #344004)

Please find enclosed the results of surface water sampling performed by NYSDEC personnel on July 12, 1991, in the vicinity of the Ramapo Landfill. Samples were collected and analyzed for Target Analyte List metals, cyanide, total organic carbons and ammonia from the following locations:

* Sample A037-T1 was collected on the Torne Brook upgradient of the Orange and Rockland substation (approximately 100 feet upstream from the power line right-of-way that heads east of the substation).

* Samples A037-R1, A037-R2 and A037-R3 were collected roughly 150 feet upstream of the former outfall 001, at the confluence with the former outfall, and roughly 150 feet downstream of the outfall, respectively, on the Ramapo River.

Please give me a call (518) 457-1641 if you have any questions about the enclosed data.

Sincerely,

Kathleen A McCue

Kathleen McCue
Project Manager
Bureau of Central Remedial Action
Div. of Hazardous Waste Remediation

Enclosure
cc: J. Lanzo, URS Consultants ✓
A. Lapidos, Ramapo Land Company
R. Nunes, USEPA, Region II

Distribution		
Am	2	
JC		
FILE		

15 (12-75)

New York State Department of Environmental Conservation

MEMORANDUM

TO: Kathleen McCue, Bureau of Central Remedial Action
FROM: Charles Vernoy, Bureau of Technical Services CAV
SUBJECT: **Ramapo LF Data Package Usability**

DATE: August 29, 1991

After review of the Weston Data Package on the Ramapo Landfill samples for metals the only QC problem was with silver. The silver QC results for the Spike Sample Recovery and the Laboratory Control Sample are both below the acceptable limits (23% and 73% respectfully). Silver data is usable and results would be biased low, but since no concentrations above the detection limit were found in any of the sample results, the silver data is acceptable.

#35 Pg 26

All other metal QC items are acceptable and the sample data is usable.

If you have any questions please phone me at 7-3252.

cc: M. Serafini

AUG 30

B.E.R.A.
FOILABLE Y-N
SITE NAME
SITE CODE
SUB SECTIONS
PRO. ELEMENT
OPERABLE UNIT NO. DESC.
DRAFT OR FINAL

FILE SECTION
____ I
____ II
____ III
____ IV
____ V
____ VI

WESTON

ROY F. WESTON, INC.
Lionville Laboratory

CLIENT: CASE RA091NYSDEC SAMPLES RECEIVED: 7-13-91
RFW #: 9107L151
W.O. #: 1667-07-01

INORGANIC NARRATIVE

The following is a summary of the quality control results and a description of any problems encountered during the analysis of this batch of samples:

1. All sample holding times as required by 40CFR136 were met for water samples.

2. All preparation blank results were below the required detection limit.

3. All laboratory control standards (blank spikes) were within the control limits of 80-120%. All %RPD were within the 20% guidance limit.

4. All calibration verification checks are within the required control limits of 90-110%. Calibration verification is performed using independent standards.

5. Matrix spike recoveries are summarized on the Inorganic Accuracy Report contained within this document. All recoveries were within the 75-125% guidance limit. All %RPD were within the 20% guidance limit.

6. Replicate results are summarized on the Inorganic Precision report contained within this document. All results were within the 20% RPD guidance limit.

7. The analytical methods applied by the laboratory, unless otherwise requested, for all inorganic analyses are derived from the USEPA Method for Chemical Analysis of Water and Wastes (USEPA 600/4-79-020), and Standard Methods for the Examination of Water and Wastewater 16 ed. Methods for the analysis of solid samples are derived from Test Methods for Evaluating Solid Waste (USEPA SW846).

#35
pg 3 of 5

8-2-91.

Jack R. Tuschall, Ph.D. Date
Laboratory Manager
Lionville Analytical Laboratory

pas\i7-151

ROY F. WESTON INC.

INORGANICS DATA SUMMARY REPORT 07/26/91

CLIENT: CASE RA091NYSDEC
WORK ORDER: 1667-07-01-0000

WESTON BATCH #: 9107L151

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-001	A749T1	Cyanide, Total	10.0 u	UG/L	10.0
		Ammonia, as N	0.10 u	MG/L	0.10
		Total Organic Carbon	1.3	MG/L	0.50
-002	A749R1	Cyanide, Total	10.0 u	UG/L	10.0
		Ammonia, as N	0.10 u	MG/L	0.10
		Total Organic Carbon	3.7	MG/L	0.50
-003	A749R3	Cyanide, Total	10.0 u	UG/L	10.0
		Ammonia, as N	0.10 u	MG/L	0.10
		Total Organic Carbon	3.7	MG/L	0.50
-004	A749R2	Cyanide, Total	10.0 u	UG/L	10.0
		Ammonia, as N	0.10 u	MG/L	0.10
		Total Organic Carbon	3.7	MG/L	0.50

#35 Pg 4 of 10

3A

WESTON

Roy F. Weston, INC.
Lionville Laboratory

CLIENT:CASE RA091 NYSDEC **SAMPLES RECEIVED:**7/13/91
RFW #:9107L151
W.O.#:1667-07-01

METALS NARRATIVE

The set of samples consisted of (4) water samples collected on 7/12/91.

The samples were analyzed according to criteria set forth in CLP SOW 7/87.

The following is a summary of the QC results accompanying these sample results and a description of any problems encountered during their analysis:

1. ICVs, CCVs, and LCSs stock standards were purchased from Inorganic Ventures Laboratory.
2. All ICV and CCV values were within control limits.
3. All ICB and CCB values were within control limits.
4. All preparation blank values were within control limits.
5. All LCS results were within the 80-120% control limits.

   Note: The USEPA has dropped control limits for antimony and silver due to documented difficulties in obtaining reliable results. WESTON Analytics has adopted the same policy.
6. All matrix spike recoveries were within the 75-125% control limits with the exception of Ag. All corresponding samples were flagged with an "N" according to CLP protocol.
7. All duplicate analyses were within the 20% RPD control limit.

#35 Pg 5 of 10

8.6.91.
Date

Jack R. Tuschall, Ph.D.
Laboratory Manager
WESTON Analytical Laboratories

WESTON

USEPA CONTRACT LABORATORY PROGRAM
DATA QUALIFIER DESCRIPTIONS
INORGANIC ANALYSIS SOW NO. 787

CONCENTRATION QUALIFIERS:

B = INDICATES THAT THE REPORTED VALUE IS LESS THAN THE CRDL BUT GREATER THAN THE IDL.

U = INDICATES THAT THE ANALYTE WAS ANALYZED FOR BUT NOT DETECTED.

QUALIFIERS:

E = THE REPORTED VALUE IS ESTIMATED BECAUSE OF THE PRESENCE OF INTERFERENCE.

M = DUPLICATE INJECTION PRECISION NOT MET.

N = SPIKED SAMPLE RECOVERY NOT WITHIN CONTROL LIMITS.

S = THE REPORTED VALUE WAS DETERMINED BY THE METHOD OF STANDARD ADDITIONS (MSA).

W = POST DIGESTION SPIKE FOR FURNACE AA ANALYSIS IS OUT OF CONTROL LIMITS (85-125%) WHILE SAMPLE ABSORBANCE IS LESS THAN 50% OF SPIKE ABSORBANCE.

* = DUPLICATE ANALYSIS NOT WITHIN CONTROL LIMITS.

+ = CORRELATION COEFFICIENT FOR THE MSA IS LESS THAN 0.995.

#35
Pg 69 of
101

METHOD:

P = ICP
A = FLAME AA
F = FURNACE AA
CV = MANUAL COLD VAPOR AA.
AV = AUTOMATED COLD VAPOR AA.
AS = SEMI-AUTOMATED SPECTROPHOTOMETRIC
C = MANUAL SPECTROPHOTOMETRIC
T = TITRIMETRIC
NR = NOT REQUIRED

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

A749T1

Lab Name: Roy F. Weston, Inc.

Contract: 1667-07-01

Lab Code: WESTON

Case No: RA091

SAS No.:

SDG No.: CLP151

Matrix (soil/water): WATER

Lab Sample ID: 9107151001

Level (low/med): LOW

Date Received: 07/13/91

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	109.40	B		P
7440-36-0	Antimony	17.10	U		P
7440-38-2	Arsenic	2.00	U		F
7440-39-3	Barium	15.50	B		P
7440-41-7	Beryllium	0.30	U		P
7440-43-9	Cadmium	1.50	U		P
7440-70-2	Calcium	5038.90		E	P
7440-47-3	Chromium	2.40	U		P
7440-48-4	Cobalt	2.40	U		P
7440-50-8	Copper	2.70	B		P
7439-89-6	Iron	110.00			P
7439-92-1	Lead	2.00	U		F
7439-95-4	Magnesium	1392.20	B	E	P
7439-96-5	Manganese	46.30		E	P
7439-97-6	Mercury	0.20	U		CV
7440-02-0	Nickel	5.70	U		P
7440-09-7	Potassium	954.20	U		P
7782-49-2	Selenium	2.00	U		F
7440-22-4	Silver	3.90	U	N	P
7440-23-5	Sodium	3232.10	B	E	P
7440-28-0	Thallium	2.00	U	W	F
7440-62-2	Vanadium	6.00	B		P
7440-66-6	Zinc	8.80	B		P
	Cyanide	10.00	U		C

#35
pg 7 of 10

Color Before: COLORLESS

Clarity Before: CLEAR

Texture:

Color After: COLORLESS

Clarity After: CLEAR

Artifacts:

Comments:

FORM I - IN

U.S. EPA - CLP

1
INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

A749R1

Lab Name:Roy F. Weston, Inc.   Contract:1667-07-01

Lab Code:WESTON   Case No:RA091   SAS No.:   SDG No.:CLP151

Matrix (soil/water):WATER   Lab Sample ID:9107151002

Level (low/med): LOW   Date Received:07/13/91

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	84.00	U		P
7440-36-0	Antimony	17.10	U		P
7440-38-2	Arsenic	2.00	U		F
7440-39-3	Barium	15.00	B		P
7440-41-7	Beryllium	0.30	U		P
7440-43-9	Cadmium	1.50	U		P
7440-70-2	Calcium	27385.40		E	P
7440-47-3	Chromium	2.40	U		P
7440-48-4	Cobalt	2.40	U		P
7440-50-8	Copper	6.30	B		P
7439-89-6	Iron	96.00	B		P
7439-92-1	Lead	2.00	U		F
7439-95-4	Magnesium	7503.40		E	P
7439-96-5	Manganese	63.90		E	P
7439-97-6	Mercury	0.20	U		CV
7440-02-0	Nickel	5.70	U		P
7440-09-7	Potassium	2725.10	B		P
7782-49-2	Selenium	2.00	U		F
7440-22-4	Silver	3.90	U	N	P
7440-23-5	Sodium	50888.40		E	P
7440-28-0	Thallium	2.00	U	W	F
7440-62-2	Vanadium	6.40	B		P
7440-66-6	Zinc	14.00	B		P
	Cyanide	10.00	U		C

#35
Pb 8

Color Before:COLORLESS   Clarity Before:CLEAR   Texture:

Color After: COLORLESS   Clarity After: CLEAR   Artifacts:

Comments:

FORM I - IN

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

A749R3

Lab Name: Roy F. Weston, Inc.

Contract: 1667-07-01

Lab Code: WESTON

Case No: RA091

SAS No.:

SDG No.: CLP151

Matrix (soil/water): WATER

Lab Sample ID: 9107151003

Level (low/med): LOW

Date Received: 07/13/91

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	84.00	U		P
7440-36-0	Antimony	17.10	U		P
7440-38-2	Arsenic	2.00	U	W	F
7440-39-3	Barium	14.50	B		P
7440-41-7	Beryllium	0.30	U		P
7440-43-9	Cadmium	1.50	U		P
7440-70-2	Calcium	28355.90		E	P
7440-47-3	Chromium	2.40	U		P
7440-48-4	Cobalt	2.40	U		P
7440-50-8	Copper	3.20	B		P
7439-89-6	Iron	140.00			P
7439-92-1	Lead	2.90	B		F
7439-95-4	Magnesium	7778.90		E	P
7439-96-5	Manganese	71.20		E	P
7439-97-6	Mercury	0.20	U		CV
7440-02-0	Nickel	5.70	U		P
7440-09-7	Potassium	2627.70	B		P
7782-49-2	Selenium	2.00	U		F
7440-22-4	Silver	3.90	U	N	P
7440-23-5	Sodium	52731.60		E	P
7440-28-0	Thallium	2.00	U	W	F
7440-62-2	Vanadium	7.10	B		P
7440-66-6	Zinc	7.30	B		P
	Cyanide	10.00	U		C

Color Before: COLORLESS

Clarity Before: CLEAR

Texture:

Color After: COLORLESS

Clarity After: CLEAR

Artifacts:

Comments:

FORM I - IN

#35
7696

U.S. EPA - CLP

1

INORGANIC ANALYSIS DATA SHEET

EPA SAMPLE NO.

A749R2

Lab Name:Roy F. Weston, Inc. Contract:1667-07-01

Lab Code:WESTON Case No:RA091 SAS No.: SDG No.:CLP151

Matrix (soil/water):WATER Lab Sample ID:9107151004

Level (low/med): LOW Date Received:07/13/91

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7429-90-5	Aluminum	84.00	U		P
7440-36-0	Antimony	17.10	U		P
7440-38-2	Arsenic	2.00	U	W	F
7440-39-3	Barium	14.50	B		P
7440-41-7	Beryllium	0.30	U		P
7440-43-9	Cadmium	1.50	U		P
7440-70-2	Calcium	27533.70		E	P
7440-47-3	Chromium	2.40	U		P
7440-48-4	Cobalt	2.40	U		P
7440-50-8	Copper	5.40	B		P
7439-89-6	Iron	125.20			P
7439-92-1	Lead	2.60	B		F
7439-95-4	Magnesium	7559.40		E	P
7439-96-5	Manganese	62.30		E	P
7439-97-6	Mercury	0.20	U		CV
7440-02-0	Nickel	5.70	U		P
7440-09-7	Potassium	2481.80	B		P
7782-49-2	Selenium	2.00	U		F
7440-22-4	Silver	3.90	U	N	P
7440-23-5	Sodium	51271.50		E	P
7440-28-0	Thallium	2.00	U		F
7440-62-2	Vanadium	7.10	B		P
7440-66-6	Zinc	14.00	B		P
	Cyanide	10.00	U		C

#35
Rc 10d
10

Color Before:COLORLESS Clarity Before:CLEAR Texture:

Color After: COLORLESS Clarity After: CLEAR Artifacts:

Comments:

FORM I - IN

APPENDIX N

WETLAND DELINEATION AND SPECIES IDENTIFIED FOR ECOLOGICAL STUDY DURING URS FIELD CHECK

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD[1]

Field Investigator(s): R. West Date: May 21, 1990
Project/Site: Ramapo Landfill State: NY County: Rockland
Applicant/Owner: Town of Ramapo Plant Community #/Name: 13/Hemlock-Northern Hardwood Forest
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes X No ____ (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes [1] X No ____ (If yes, explain on back)

VEGETATION

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1. Tsuga canadensis	FACU	T	11.		
2. Quercus rubra	FACU	T	12.		
3. Quercus alba	FACU	T	13.		
4. Acer rubrum	FAC	T	14.		
5. Betula allegheniensis	FAC	T	15.		
6. Sassafras albidium	FACU	T	16.		
7. Alnus sp	FACW	S	17.		
8. Cornus florida	FACU	S	18.		
9. Maianthemum canadense	FAC	F	19.		
10. Onoclea sensibilis	FACW	F	20.		

Percent of dominant species that are OBL, FACW, and/or FAC 50
Is the hydrophytic vegetation criterion met? Yes ____ No X
Rationale: FAC and FACW do not exceed 50% of dominant species

SOILS

Series/phase: Chatfield-Charlton-Hollis-Rock Outcrop Subgroup:[2] entire series present
Is the soil on the hydric soils list? Yes ____ No X Undetermined ____
Is the soil a Histosol? Yes ____ No X Histic epipedon present? Yes ____ No ____ unknown
Is the soil: Mottled? Yes ____ No ____ Gleyed? Yes ____ No ____ unknown
Matrix Color: unknown Mottle Colors: unknown
Other hydric soil indicators: none known
Is the hydric soil criterion met? Yes ____ No X
Rationale: No soils of this series are listed in "New York Hydric Soils" (Soil Conservation Service March, 1989).

HYDROLOGY

Is the ground surface inundated? Yes ____ No X Surface water depth: ____
Is the soil saturated? Yes ____ No X
Depth to free-standing water in pit/soil probe hole: Unknown. Soil Survey says water table >6.0ft.
List other field evidence of surface inundation or soil saturation.
none known
Is the wetland hydrology criterion met? Yes ____ No X
Rationale: No evidence of inundation

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes ____ No X
Rationale for jurisdictional decision: None of the three criteria are met.

---

[1] This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
[2] Classification according to "Soil Taxonomy."

[1] The Hemlock-Northern Hardwood Forest areas are adjacent to, and both upgradient and downgradient of, the area disturbed by the landfill.

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD[1]

Field Investigator(s): R. West Date: May 21, 1990
Project/Site: Ramapo Landfill State: NY County: Rockland
Applicant/Owner: Town of Ramapo Plant Community #/Name: 8/Oak-Tuliptree Forest
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes x No ___ (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes ___ No x (If yes, explain on back)

VEGETATION

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1. Quercus rubra	FACU	T	11.		
2. Acer rubrum	FAC	T	12.		
3. Tsuga canadensis	FACU	T	13.		
4. Quercus alba	FACU	T	14.		
5. Liriodendron tulipifera	FACU	T	15.		
6. Hamamelis virginiana	FAC	S	16.		
7. Viburnum sp	FACU	S	17.		
8. Polystichum acrostichoides	FACU	F	18.		
9. Cornus florida	FACU	S	19.		
10. Ceranium sp	FACU	F	20.		

Percent of dominant species that are OBL, FACW, and/or FAC 20
Is the hydrophytic vegetation criterion met? Yes ___ No X
Rationale:

SOILS

Series/phase: Chatfield-Charlton-Hollis-Rock Outcrop Subgroup:[2] Alden Silt Loam
Is the soil on the hydric soils list? Yes X No ___ Undetermined ___
Is the soil a Histosol? Yes ___ No X Histic epipedon present? Yes ___ No ___ unknown
Is the soil: Mottled? Yes ___ No ___ Gleyed? Yes ___ No ___ unknown
Matrix Color: unknown Mottle Colors: unknown
Other hydric soil indicators: none known
Is the hydric soil criterion met? Yes ___ No Not likely
Rationale: According to soil survey, no saturation of this soil unit occurs during growing season.

HYDROLOGY

Is the ground surface inundated? Yes unknown No ___ Surface water depth:
Is the soil saturated? Yes ___ No ___ unknown
Depth to free-standing water in pit/soil probe hole: unknown
List other field evidence of surface inundation or soil saturation.
none known
Is the wetland hydrology criterion met? Yes ___ No not likely
Rationale: According to soil survey, no saturation of this soil unit occurs during growing season

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes ___ No X
Rationale for jurisdictional decision: Low percentage of potentially hydrophytic dominant species; no apparent saturation of soils during growing season; presence of a roadway with minimal vegetation across this relatively small occurence of Alden Silt Loam

[1] This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
[2] Classification according to "Soil Taxonomy."

DATA FORM
ROUTINE ONSITE DETERMINATION METHOD[1]

Field Investigator(s): R. West Date: May 21, 1990
Project/Site: Ramapo Landfill State: NY County: Rockland
Applicant/Owner: Town of Ramapo Plant Community #/Name: 22/Successional Old Field
Note: If a more detailed site description is necessary, use the back of data form or a field notebook.

Do normal environmental conditions exist at the plant community?
Yes ____ No X[1] (If no, explain on back)
Has the vegetation, soils, and/or hydrology been significantly disturbed?
Yes X[1] No ____ (If yes, explain on back)

VEGETATION

Dominant Plant Species	Indicator Status	Stratum	Dominant Plant Species	Indicator Status	Stratum
1. Populus deltoides	FAC	T	11.		
2. Salix nigra	FACW	T	12.		
3. Robinia pseudoaccacia	FACW	T	13.		
4. Rubus sp	FAC	S	14.		
5. Rosa sp	FAC	S	15.		
6. Parthenocissus cinquefolia	FACU	WV	16.		
7. Solidago sp	FAC	F	17.		
8. Trifolium repens	FACU	F	18.		
9. Potentilla sp	FACW	F	19.		
10. Lotus corniculatus	FACU	F	20.		

Percent of dominant species that are OBL, FACW, and/or FAC 60
Is the hydrophytic vegetation criterion met? Yes X No ____
Rationale: Greater than 50% of dominant species are FAC or FACW

SOILS

Series/phase: Chatfield-Charlton-Hollis-Rock Outcrop Subgroup:[2] Charlton fine sandy loam 15-35 & Pits
Is the soil on the hydric soils list? Yes ____ No X Undetermined ____
Is the soil a Histosol? Yes ____ No X Histic epipedon present? Yes ____ No ____ unknown
Is the soil: Mottled? Yes ____ No ____ Gleyed? Yes ____ No ____ unknown
Matrix Color: ____ Mottle Colors: unknown
Other hydric soil indicators: none known
Is the hydric soil criterion met? Yes ____ No ____ unknown
Rationale: Not met in Charlton area. May be met in pit(i.e. excavated)area.

HYDROLOGY

Is the ground surface inundated? Yes ____ No X Surface water depth: ____
Is the soil saturated? Yes ____ No X
Depth to free-standing water in pit/soil probe hole: None encountered
List other field evidence of surface inundation or soil saturation.
None known
Is the wetland hydrology criterion met? Yes ____ No X
Rationale: No evidence of soil saturation or inundation

JURISDICTIONAL DETERMINATION AND RATIONALE

Is the plant community a wetland? Yes ____ No X
Rationale for jurisdictional decision:
Hydrology criterion is clearly not met.

---

[1] This data form can be used for the Hydric Soil Assessment Procedure and the Plant Community Assessment Procedure.
[2] Classification according to "Soil Taxonomy."

[1] The area has been significantly disturbed by excavation, earth-moving and deposition of waste.

APPENDIX N

Plant species identified during May 1990 Field Checks are listed in approximate order of frequency of occurrence. Category locations are shown on RI Figure 3-1A.

Category I:	Common Name	Scientific Name
Canopy:	Red Oak	Quercus rubra
	Red Maple	Acer rubrum
	Canadian Hemlock	Tsuga canadensis
	White Oak	Quercus alba
	Tulip Tree	Liriodendron tulipifera
	Downy Juneberry	Amelanchier arborea
	Shagbark Hickory	Carya ovata
	American Beech	Fagus sylvatica
	Sugar Maple	Acer saccharum
	Sycamore	Platanus occidentalis
	White Ash	Fraxinus americana
Understory:	Witch-hazel	Hammamelis virginiana
	Maple-leaf Viburnum	Viburnum acerifolia
	Flowering Dogwood	Cornus florida
	Mountain Laurel	Kalmia latifolia
	Azalea	Azalea spp.
	Honeysuckle	Lonicera spp.
Groundcovers:	Geranium	Geranium spp.
	Christmas Fern	Polystichum lonchitis
	Hay scented Fern	Dennstaedtia punctilobula
	Sensitive Fern	Onoclea sensibilis

Category II:	Common Name	Scientific Name
Canopy:	Canadian Hemlock	Tsuga canadensis
	Red Oak	Quercus rubra
	White Oak	Quercus alba
	Red Maple	Acer rubrum
	Yellow Birch	Betula alleghaniensis
Understory:	Sassafras	Sassafras albidum
	Alder	Alnus spp.
	Flowering Dogwood	Cornus florida
Groundcover:	Canada Mayflower	Maianthemum canadense
	Sensitive Fern	Onoclea sensibilis
	Bedstraw	Galium spp.

Category III:	**Common Name**	**Scientific Name**
Herbaceous:	Goldenrod	Solidage spp.
	White Clover	Trifolium repens
	Cinquefoil	Potentila spp.
	Birdsfoot Trefoil	Lotus corniculatus
	Reedgrass	Phragmites spp.
Woody (low growing):	Virginia Creeper	Parthenocissus cinquefolia
	Raspberry	Rubus spp.
	Rose	Rosa spp.
	Grape Vine	Vitis spp.
	Poison Ivy	Rhus toxicodendron
	Elderberry	Sambuca spp.
Trees:	Easten Cottonwood	Populus deltoides
	Black Willow	Salix nigra
	Shrub Willow	Salix spp.
	Black Locust	Robinia psuedoaccacia
	Tree-of-heaven	Ailanthus altissima
	Red Mulberry	Morus rubra
	Catalpa	Catalpa speciosa
	Staghorn Sumac	Rhus typhina

Category IV: A mixture of species from Areas I and III

APPENDIX P

CALCULATIONS

APPENDIX P.1

STREAM DISCHARGE CALCULATIONS

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SUBJECT STREAM DISCHARGE CALCULATIONS

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$$q_i = V_i d_i w_i$$

q = SEGMENT DISCHARGE (Ft^3/SEC)
V = SEGMENT AVERAGE VELOCITY (FT/SEC)
d = SEGMENT DEPTH × 0.6 (FT)
w = SEGMENT WIDTH (FT)

$$Q = \sum_{i=1}^{m} q_i$$

Q = TOTAL DISCHARGE

LOCATION 1 - 10/24/89

CANDLE BROOK - 40 FT EAST OF BAILER BUILDING

$q_1 = 0 \times 0.2 \times 0.5$ $\qquad q_1 = 0.0 \; Ft^3/SEC$
$q_2 = 2.0 \times 0.5 \times 0.5$ $\qquad q_2 = 0.5$
$q_3 = 0.4 \times 0.8 \times 0.5$ $\qquad q_3 = 0.16$
$q_4 = 1.2 \times 0.4 \times 0.5$ $\qquad q_4 = 0.24$
$q_5 = 0.0 \times 0.1 \times 0.5$ $\qquad q_5 = 0.0$
$q_6 = 0.0 \times 0.3 \times 0.5$ $\qquad q_6 = 0.0$

$Q = 0.9 \; Ft^3/SEC$

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LOCATION 2 – 10/24/89

CANDLE BROOK AT CULVERT

$q_1 = 0.0 \times 0.0 \times 0.5$ $q_1 = 0.0$ FT³/SEC

$q_2 = 0.4 \times 0.2 \times 0.5$ $q_2 = 0.04$

$q_3 = 1.5 \times 0.4 \times 0.5$ $q_3 = 0.3$

$q_4 = 0.6 \times 0.2 \times 0.5$ $q_4 = 0.06$

$q_5 = 0.0 \times 0.0 \times 0.5$ $q_5 = 0.0$

$Q = 0.4$ FT³/SEC

LOCATION 3 – 10/24/89

TORNE BROOK – 50 FT DOWNSTREAM OF CANDLE BROOK

$q_1 = 0.2 \times 0.38 \times 1.0$ $q_1 = 0.08$ FT³/SEC

$q_2 = 0.2 \times 0.33 \times 1.0$ $q_2 = 0.07$

$q_3 = 0.3 \times 0.33 \times 1.0$ $q_3 = 0.10$

$q_4 = 0.1 \times 0.42 \times 1.0$ $q_4 = 0.04$

$q_5 = 0.6 \times 0.54 \times 1.0$ $q_5 = 0.32$

$q_6 = 1.3 \times 0.58 \times 1.0$ $q_6 = 0.75$

$q_7 = 1.1 \times 0.75 \times 1.0$ $q_7 = 0.83$

$q_8 = 0.6 \times 0.83 \times 1.0$ $q_8 = 0.50$

$q_9 = 0.8 \times 0.92 \times 1.0$ $q_9 = 0.74$

$q_{10} = 1.3 \times 0.75 \times 1.0$ $q_{10} = 0.98$

$q_{11} = 0.4 \times 0.92 \times 1.0$ $q_{11} = 0.37$

$q_{12} = 0.8 \times 0.83 \times 1.0$ $q_{12} = 0.66$

$q_{13} = 0.9 \times 0.83 \times 1.0$ $q_{13} = 0.75$

$q_{14} = 0.4 \times 0.67 \times 1.0$ $q_{14} = 0.27$

$q_{15} = 0.7 \times 0.75 \times 1.0$ $q_{15} = 0.53$

$q_{16} = 0.3 \times 0.58 \times 1.0$ $q_{16} = 0.17$

$q_{17} = 0.2 \times 0.42 \times 1.0$ $q_{17} = 0.08$

$Q = 7.24$ FT³/SEC

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Location 4 - 10/24/89

Torne Brook - 50 ft downstream of paint sludge on bank

$q_1 = 0.9 \times 0.75 \times 1.0$ $q_1 = 0.68$ ft³/sec
$q_2 = 0.8 \times 0.83 \times 1.0$ $q_2 = 0.66$
$q_3 = 0.7 \times 0.83 \times 1.0$ $q_3 = 0.58$
$q_4 = 0.9 \times 0.50 \times 1.0$ $q_4 = 0.45$
$q_5 = 0.5 \times 0.50 \times 1.0$ $q_5 = 0.25$
$q_6 = 0.2 \times 0.42 \times 1.0$ $q_6 = 0.08$
$q_7 = 0.6 \times 0.33 \times 1.0$ $q_7 = 0.20$
$q_8 = 1.0 \times 0.58 \times 1.0$ $q_8 = 0.58$
$q_9 = 0.8 \times 1.00 \times 1.0$ $q_9 = 0.80$
$q_{10} = 0.4 \times 1.00 \times 1.0$ $q_{10} = 0.40$
$q_{11} = 0.3 \times 1.08 \times 1.0$ $q_{11} = 0.32$
$q_{12} = 0.2 \times 1.17 \times 1.0$ $q_{12} = 0.23$
$q_{13} = 0.1 \times 1.17 \times 1.0$ $q_{13} = 0.12$
$q_{14} = 0.1 \times 1.17 \times 1.0$ $q_{14} = 0.12$
$q_{15} = 0.2 \times 1.17 \times 1.0$ $q_{15} = 0.23$
$q_{16} = 0.6 \times 1.25 \times 1.0$ $q_{16} = 0.75$
$q_{17} = 0.6 \times 1.17 \times 1.0$ $q_{17} = 0.70$
$q_{18} = 1.2 \times 1.00 \times 1.0$ $q_{18} = 1.20$
$q_{19} = 0.4 \times 1.17 \times 1.0$ $q_{19} = 0.47$
$q_{20} = 0.7 \times 1.25 \times 1.0$ $q_{20} = 0.88$
$q_{21} = 0.3 \times 1.42 \times 1.0$ $q_{21} = 0.43$
$q_{22} = 1.1 \times 1.42 \times 1.0$ $q_{22} = 1.56$

$Q = 11.69$ ft³/sec

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Location 5 - 10/24/89

Torne Brook at Stream Gauge

$q_1 = 0.1 \times 0.42 \times 1.0$ $\quad q_1 = 0.04$ Ft³/Sec

$q_2 = 0.1 \times 0.58 \times 1.0$ $\quad q_2 = 0.06$

$q_3 = 0.4 \times 0.50 \times 1.0$ $\quad q_3 = 0.20$

$q_4 = 1.2 \times 0.75 \times 1.0$ $\quad q_4 = 0.90$

$q_5 = 1.2 \times 0.83 \times 1.0$ $\quad q_5 = 1.00$

$q_6 = 1.7 \times 1.17 \times 1.0$ $\quad q_6 = 1.99$

$q_7 = 1.5 \times 1.58 \times 1.0$ $\quad q_7 = 3.08$

$q_8 = 1.5 \times 2.08 \times 1.0$ $\quad q_8 = 3.12$

$q_9 = 1.2 \times 2.08 \times 1.0$ $\quad q_9 = 2.50$

$q_{10} = 0.5 \times 1.92 \times 1.0$ $\quad q_{10} = 0.97$

$q_{11} = 1.1 \times 2.00 \times 1.0$ $\quad q_{11} = 2.20$

$Q = 16.05$ Ft³/Sec

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LOCATION 6   10/25/89

RAMAPO RIVER - 20 FT DOWNSTREAM OF TORNE BROOK

$q_1 = 0.6 \times 2.00 \times 5.0$ $q_1 = 6.00$ FT^3/SEC
$q_2 = 2.1 \times 2.50 \times 5.0$ $q_2 = 26.25$
$q_3 = 3.0 \times 3.50 \times 5.0$ $q_3 = 52.50$
$q_4 = 3.6 \times 3.50 \times 5.0$ $q_4 = 63.00$
$q_5 = 3.6 \times 3.50 \times 5.0$ $q_5 = 63.00$
$q_6 = 4.6 \times 4.00 \times 5.0$ $q_6 = 92.00$
$q_7 = 5.0 \times 4.00 \times 5.0$ $q_7 = 100.00$
$q_8 = 4.1 \times 3.50 \times 5.0$ $q_8 = 71.75$
$q_9 = 3.3 \times 2.08 \times 5.0$ $q_9 = 34.32$
$q_{10} = 2.2 \times 1.42 \times 5.0$ $q_{10} = 15.62$
$q_{11} = 2.1 \times 1.08 \times 5.0$ $q_{11} = 11.34$
$q_{12} = 1.5 \times 0.92 \times 5.0$ $q_{12} = 6.90$
$q_{13} = 0.2 \times 0.50 \times 5.0$ $q_{13} = 0.50$

$Q = 543.18$ FT^3/SEC

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<u>Location 7</u> - 10/30/89

Ramapo River - 20 ft downstream of Torne Brook

$q_1 = 0.0 \times 0.67 \times 5.0$ $q_1 = 0.0$ ft^3/sec

$q_2 = 0.2 \times 1.42 \times 5.0$ $q_2 = 1.42$

$q_3 = 0.7 \times 2.25 \times 5.0$ $q_3 = 7.88$

$q_4 = 1.8 \times 2.67 \times 5.0$ $q_4 = 24.03$

$q_5 = 1.7 \times 2.25 \times 5.0$ $q_5 = 19.13$

$q_6 = 2.3 \times 2.75 \times 5.0$ $q_6 = 31.63$

$q_7 = 2.7 \times 3.50 \times 5.0$ $q_7 = 47.25$

$q_8 = 3.1 \times 4.00 \times 5.0$ $q_8 = 62.00$

$q_9 = 3.5 \times 3.50 \times 5.0$ $q_9 = 61.25$

$q_{10} = 3.4 \times 2.50 \times 5.0$ $q_{10} = 42.50$

$q_{11} = 2.4 \times 1.50 \times 5.0$ $q_{11} = 18.00$

$q_{12} = 0.4 \times 0.67 \times 5.0$ $q_{12} = 1.34$

$Q = 316.43$ ft^3/sec

APPENDIX P.2

SEDIMENT CLEANUP CALCULATIONS

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PROJECT Ramapo Landfill
SUBJECT Calculation of Sediment Criteria

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Summary Table

Compound	Sediment Criterion for SS-3 (µg/Kg)	SS-4	AWQS/GV µg/l	H or A*	Results SS-3 µg/Kg	SS-4
4-Methylphenol	N/A	N/A	none	H	ND	150 j
Benzoic Acid	N/A	N/A	none	H	ND	310 j
Phenanthrene	21,600	47,600	50	H	ND	75 j
Flouranthrene	160,000	353,000	50	H	40 j	110 j
Pyrene	56,900	125,000	50	H	46 j	160 j
Benz(a)anthracene	12	27	.002	H	ND	65 j
Chrysene	12	27	.002	H	ND	83 j
Benz(b)flouranthrene	110	250	.002	H	ND	150 j
Bis (2-ethylhexyl)-phthalate	12,000 1,800	26,000 4,000	4 0.6	H A	45 j	100 j
Benz(k)flouranthrene	210	460	.002	H	ND	63 j
Benz(a)pyrene	33 20	73 43	.002 .0012	H A	ND	59 j
Gamma-Chlordane	.18 .018	.40 .040	.02 .002	H A	ND	12 j

* H: Human health based
A: aquatic organism health based
J: estimated value

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Ambient Water Quality Standards / Guidance Values			log K_{ow} ~~REF.~~ PAGE
① 4-Methyl phenol			1.94
② Benzoic Acid			1.87
③ phenanthrene	50 µg/l	(GV)	4.46
④ Flouranthrene	50 µg/l	(GV)	5.33
⑤ Pyrene	50 µg/l	(GV)	4.88
⑥ Benz(a) anthracene	.002 µg/l	(GV)	5.61
⑦ chrysene	.002 µg/l	(GV)	5.61
⑧ Benz(b) flouranthrene	.002 µg/l	(GV)	6.57
⑨ Bis(2-ethylhexyl) phthalate	4 µg/l	(GV)	5.3
⑩ Benz(k) flouranthrene	.002	(GV)	6.84
⑪ Benz(a) pyrene	.002	(GV)	6.04
⑫ Gamma-chlordane ("chlordane"	.02 H .002 A	(GV))	2.68

<u>Organic Carbon</u>

stream Sediment location #3 = 1.50%
" " " #4 = 3.30%

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location SW3 $O.C. = 1.50\% = \frac{15g}{Kg}$
location SW4 $O.C. = 3.30\% = \frac{33g}{Kg}$

<u>phenanthrene</u>

AWQS/GV = 50 μg/l (ref 5)
log Kow = 4.46 (ref 4)
phenanthrene sediment Criterion =

$$= 50 \frac{\mu g}{l} \times 10^{4.46} \left(\frac{1\ Kg}{1000\ g} \right) = 1{,}442\ \mu g/goc$$

site specific criterion - location 3

$$= 1{,}442 \frac{\mu g}{goc} \cdot \frac{15\ goc}{Kg\ soil} = \underline{21{,}630}\ \mu g/Kg\ soil$$

site specific criterion - location 4

$$= 1{,}442 \frac{\mu g}{goc} \cdot \frac{33\ goc}{Kg\ soil} = \underline{47{,}586\ \mu g}/Kg\ soil$$

<u>Flouranthrene</u>

AWQS/GV = 50 μg/l (ref 5)
log Kow = 5.33 (ref 4)

Flouranthrene sediment criterion =

$$= 50 \frac{\mu g}{l} \times 10^{5.33} \left(\frac{1\ Kg}{1000\ g} \right) = 10{,}690 \frac{\mu g}{goc}$$

site specific criterion - location 3

$$= 10{,}690 \frac{\mu g}{goc} \cdot \frac{15\ goc}{Kg\ soil} = \underline{160{,}347\ \mu g}/Kg\ soil$$

site specific criterion - location 4

$$= 10{,}690 \frac{\mu g}{goc} \cdot \frac{33\ goc}{Kg\ soil} = \underline{352{,}770\ \mu g}/Kg\ soil$$

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Pyrene

AWQS/GV = 50 $\mu g/\ell$ (ref 5)
log Kow = 4.88 (ref 1, table 1-4)
sediment criterion = $50 \frac{\mu g}{\ell} \cdot 10^{4.88} \left(\frac{1 \text{ Kg}}{1000 \text{ g}}\right) = 3{,}793$
site specific criterion, location 3
$3{,}793 \frac{\mu g}{g OC} \cdot \frac{15 \text{ g OC}}{\text{Kg Soil}} = \underline{56{,}895 \frac{\mu g}{\text{Kg soil}}}$
site specific criterion, location 4
$3{,}793 \frac{\mu g}{g OC} \cdot \frac{33 \text{ g OC}}{\text{Kg Soil}} = \underline{125{,}169 \ \mu g/\text{Kg soil}}$

Benz(a)anthracene

AWQS/GV = .002 $\mu g/\ell$ (ref 5)
log Kow = 5.61 (ref 4)
sediment criterion = $.002 \frac{\mu g}{\ell} \cdot 10^{5.61} \left(\frac{1 \text{ Kg}}{1000 \text{ g}}\right) = .815 \frac{\mu}{g}$
site specific criterion, site 3
$.815 \frac{\mu g}{g OC} \times \frac{15 \text{ g OC}}{\text{Kg Soil}} = \underline{12.2 \ \mu g/\text{Kg soil}}$
site specific criterion, location 4
$.815 \frac{\mu g}{g OC} \times \frac{33 \text{ g OC}}{\text{Kg Soil}} = \underline{26.9 \ \mu g/\text{Kg Soil}}$

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Chrysene

AWQS/GV = .002 μg/l (ref 5)

log Kow = 5.61 (ref 4)

Sediment Criterion = $.002 \frac{\mu g}{l} \cdot 10^{5.61} \left(\frac{1\,Kg}{1000\,g}\right) = .815$

site specific criterion, location 3

$= .815 \frac{\mu g}{g\,OC} \cdot \frac{15\,g\,OC}{Kg\,Soil} = \underline{12.2\ \mu g/Kg\ soil}$

site specific criterion, location 4

$= .815 \frac{\mu g}{g\,OC} \cdot \frac{33\,g\,OC}{Kg\,Soil} = \underline{26.9\ \mu g/Kg\ Soil}$

Benz(b)flouranthene

AWQS/GV = .002 μg/l (ref 5)

log Kow = 6.57 (ref 4)

Sediment Criterion = $.002 \frac{\mu g}{l} \cdot 10^{6.57} \left(\frac{1\,Kg}{1000\,g}\right) = 7.43$

site specific criterion, location 3

$= 7.43 \frac{\mu g}{g\,OC} \cdot 15 \frac{g\,OC}{Kg\,soil} = \underline{111\ \mu g/Kg\ soil}$

site specific criterion, location 4

$= 7.43 \frac{\mu g}{g\,OC} \cdot 33 \frac{g\,OC}{Kg\,soil} = \underline{245\ \mu g/Kg\ Soil}$

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Bis (2-ethylhexyl) phthalate (for aquatic organism based criteria, see page 9)

AWQS/GV = 4 μg/l (ref 5)

log Kow = 5.3 (ref 3)

Sediment Criterion = $4 \frac{\mu g}{l} \cdot 10^{5.3} \left(\frac{1\ Kg}{1000\ g}\right) = 798$

site Specific criterion, location 3

$= 798 \frac{\mu g}{g\ OC} \cdot 15 \frac{g\ OC}{Kg} =$ 11,972 μg/Kg soil

site specific Criterion, location 4

$= 798 \frac{\mu g}{g\ OC} \cdot 33 \frac{g\ OC}{Kg} =$ 26,334 μg/Kg soil

Benz (k) flouranthene

AWQS/GV = .002 μg/l (ref 5)

log Kow = 6.84 (ref 4)

Sediment Criterion = $.002 \frac{\mu g}{l} \cdot 10^{6.84} \left(\frac{1\ Kg}{1000\ g}\right) = 13.8$

Site specific criterion, location 3

$= 13.8 \frac{\mu g}{g\ OC} \cdot \frac{15\ g\ OC}{Kg\ Soil} =$ 208 μg/Kg soil

site specific criterion

$= 13.8 \frac{\mu g}{g\ OC} \cdot 33 \frac{g\ OC}{Kg\ Soil} =$ 457 μg/Kg Soil

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Benz (a) pyrene

(ref 5) AWQS/GV = .002 $\frac{\mu g}{l}$ Human ; = .0012 $\frac{\mu g}{l}$ Aquatic

log Kow = 6.04 (ref 4)

Human Sediment Criterion = .002 $\frac{\mu g}{l} \cdot 10^{6.04} \left(\frac{1 Kg}{1000 g}\right)$ = 2.2

site Specific Criterion, location 3

$= 2.2 \frac{\mu g}{g\ OC} \cdot 15 \frac{g\ OC}{Kg\ Soil}$ = 33 μg/Kg Soil

site specific Criterion, location 4

$= 2.2 \frac{\mu g}{g\ OC} \cdot 33 \frac{g\ OC}{Kg\ Soil}$ = 73 μg/Kg Soil

Aquatic Sediment Criterion = .0012 $\frac{\mu g}{l} \cdot 10^{6.04} \left(\frac{1}{1000}\right)$ = 1.3

Site Specific Criterion, location 3

$= 1.3 \frac{\mu g}{g\ OC} \cdot 15 \frac{g\ OC}{Kg\ Soil}$ = 19.7 μg/Kg Soil

site specific criterion, location 4

$= 1.3 \frac{\mu g}{g\ OC} \cdot 33 \frac{g\ OC}{Kg\ Soil}$ = 42.9 μg/Kg Soil

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Gamma Chlordane

(ref5) AWQS/GV "chlordane" = .02 μg/l human health
.002 μg/l aquatic organism

log Kow = 2.78 (ref 6)

Human Health

Sediment Criterion $= .02 \frac{\mu g}{l} \cdot 10^{2.78} \left(\frac{1 Kg}{1000 g}\right) = .012 \frac{\mu}{g O}$

site specific criterion, location 3

$= .012 \frac{\mu g}{g OC} \cdot 15 \frac{g OC}{Kg\ Soil} =$ 0.18 μg/Kg Soil

site specific Criterion, location 4

$= .012 \frac{\mu g}{g OC} \cdot 33 \frac{g OC}{Kg\ Soil} =$ 0.40 μg/Kg Soil

Aquatic Organism Health

Sediment Criterion $= .002 \frac{\mu g}{l} \cdot 10^{2.78} \left(\frac{1 Kg}{1000 g}\right) = .0012 \frac{\mu}{g O}$

site specific criterion, location 3

$= .0012 \frac{\mu g}{g OC} \cdot 15 \frac{g OC}{Kg\ Soil} =$ .018 μg/Kg Soil

site specific Criterion, location 4

$= .0012 \frac{\mu g}{g OC} \cdot 15 \frac{g OC}{Kg\ Soil} =$ .040 μg/Kg Soil

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SUBJECT Sediment Criteria

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APPENDIX P.3

GROUNDWATER FLOW MODELING AND SOLUTE TRANSPORT ANALYSIS

GROUNDWATER FLOW MODELING

The three-dimensional groundwater flow model developed was used to represent existing conditions at site, to evaluate remedial technologies associated with groundwater containment and collection, and to aid in the contaminant transport calculations which were done by hand. In evaluating remedial technologies, all uncertainties and sensitivities inherent in looking at one remedial technology would therefore be applied to all technologies. The model was based on URS field observations and measurements and information gathered during the Remedial Investigation. As part of our field investigations, URS concentrated on obtaining information on the landfill site, the Torne Brook Farm property, and the existing leachate collection system. Most of the site is situated within a small aquifer tributary to Torne Brook as defined in "The Geohydrology of the Valley - Fill Aquifer in the Ramapo and Mohawk River Area, Rockland County, New York" (USGS, 1982). Hydrogeologic data obtained for the purposes of the remedial investigation should not and was not extrapolated beyond this small aquifer into the Ramapo River Aquifer, in which the Spring Valley Water Co. water supply wells are located.

The model was calibrated to water levels measured on August 26, 1990, a day for which the monitored values were available for all wells, piezometers and manholes. On this day, the potentiometric surfaces measured were similar to those measured on other days, and therefore were representative of average conditions. Stream surface water elevations used were measured on September 11, 1990. It is not anticipated that the surface water elevations in Torne Brook and the Ramapo River, which are approximately two feet and four feet deep, respectively, would greatly vary in this time span. The following provides details of the groundwater flow modeling effort.

APPROACH

The 3-D computer model used in this study was the Modular Three-Dimensional Finite-Difference Groundwater Flow Model, prepared by the U.S. Geological Survey (McDonald and Harbaugh, 1984). The latest version (2.0) of the program was used (MODFLOW/EM). Groundwater flow within the aquifer is simulated using a block-centered finite-difference approach. Layers can be simulated as confined, unconfined or a combination of both. Flow from external stresses, such as recharge through infiltration, withdrawal from wells, flow into drains, flow through riverbeds and evapotranspiration can be simulated. The finite-difference equation can be solved using the strongly implicit procedure, slice-successive over relaxation or a preconditioned conjugate gradient solver. The model can be used for either 2-D or 3-D simulations and is capable of analyzing both steady state and transient flow.

In this case 3-D steady state conditions were used for the calibration of the model. The process of calibration was conducted utilizing an inverse problem program, for which MODFLOW is a pre-processor. The program (MODINV) was developed by the Australian Centre for Tropical Freshwater Research. It utilizes a Gauss-Marquardt method of parameter optimization. Modeled and observed heads are matched according to the weighted least-square criterion. MODINV can be used for both steady state and transient flow and can estimate up to 3 parameters, whenever it is mathematically feasible. All features of MODFLOW, such as confined and unconfined layers, wells, drains, etc. are also supported.

HYDROGEOLOGY

Four hydrogeologic units were identified in Section 3.7.3 of the RI. They include:

- Fill - mostly municipal waste

- Shallow aquifer - dense to loose sands
- Intermediate aquifer - weathered bedrock
- Bedrock aquifer - fractured bedrock.

Hydrologic properties for each of these units are summarized below from the RI and Appendices.

The fill, the shallow aquifer and the weathered bedrock were combined into one unit - the upper aquifer for modeling purposes. The weathered bedrock, although consisting of different geologic formations, displays similar hydraulic conductivities as the shallow aquifer. Also, the water levels measured in the intermediate wells were mostly similar to those recorded in the shallow wells. In addition, the weathered bedrock layer was found to have a very small thickness - from a few inches to about 5 feet.

Fill (waste layer) was included into the upper aquifer because of the limitations imposed by the model. The areal extent of the fill is smaller than the modeled area. This situation cannot be handled by MODFLOW which simulates only layers that stretch continuously over the entire modeled area. Therefore, fill had to be incorporated into the upper aquifer. This, however, does not impair the accuracy of the model as the existence of fill can be accounted for by the spacial variations of the parameters within the upper aquifer (e.g. hydraulic conductivities).

UPPER AQUIFER

The upper aquifer is made up of dense sands in the northern portion of the site and loose sands in the southern portion, adjacent to the Ramapo River. Hydraulic conductivity values obtained from slug tests for dense sands varied between 10^{-3} cm/s and 10^{-5} cm/s. The conductivity of loose sands is about 10^{-2} cm/s. (Values were obtained from slug tests.)

The thickness of the undisturbed portion of the upper aquifer in the modeled area is about 20 to 30 ft in the northern portion of the site and increases to about 50 ft approaching the Ramapo River. However, between Torne Valley Rd. to the northwest and the natural boundary of the aquifer to the southeast, the sandy material of the upper aquifer was largely removed and replaced with waste. In those areas, especially between piezometers P-3 and P-5 and in the vicinity of the piezometer P-2, the thickness of the waste layer reaches 70-80 ft. The hydraulic conductivity of the waste layer is not known, as no slug tests were conducted in that area. Fill in general, however, is considered fairly permeable. The US Army Corps of Engineers HELP model recommends the value of 2 X 10^{-4} cm/sec to be used as a hydraulic conductivity of municipal waste.

There is a large variation in water levels measured within the upper aquifer. They range from 515 ft in piezometer P-2 to 293.5 ft in stream gauge SG-2 on the Ramapo River. Very steep water level gradients are present across the site, in some areas reaching 0.33 ft/ft.

The saturated thickness of the upper aquifer varies between 10 ft and 30 ft. in its undisturbed portion and reaches about 60 ft. in the waste layer.

BEDROCK AQUIFER

A number of wells were drilled into the bedrock aquifer. Hydraulic conductivity tests show a wide variation of values ranging from 10^{-2} cm/s to 10^{-6} cm/s. Flow through bedrock differs from the flow in the upper aquifer which is typical of porous media. Flow through bedrock in the vicinity of Ramapo Landfill is more typical of flow in a fractured media. The bedrock was included in the model because of its significant importance in the overall water budget. The thickness of the fractured bedrock was assumed as being 25 ft based on the boring logs.

A large variation in the hydraulic heads occurs across the site within the bedrock aquifer. They range from 440.75 ft in MW-4 to 295.61 ft in MW-7.

Using the hydrogeologic information above, a three-dimensional groundwater flow model was developed as described below.

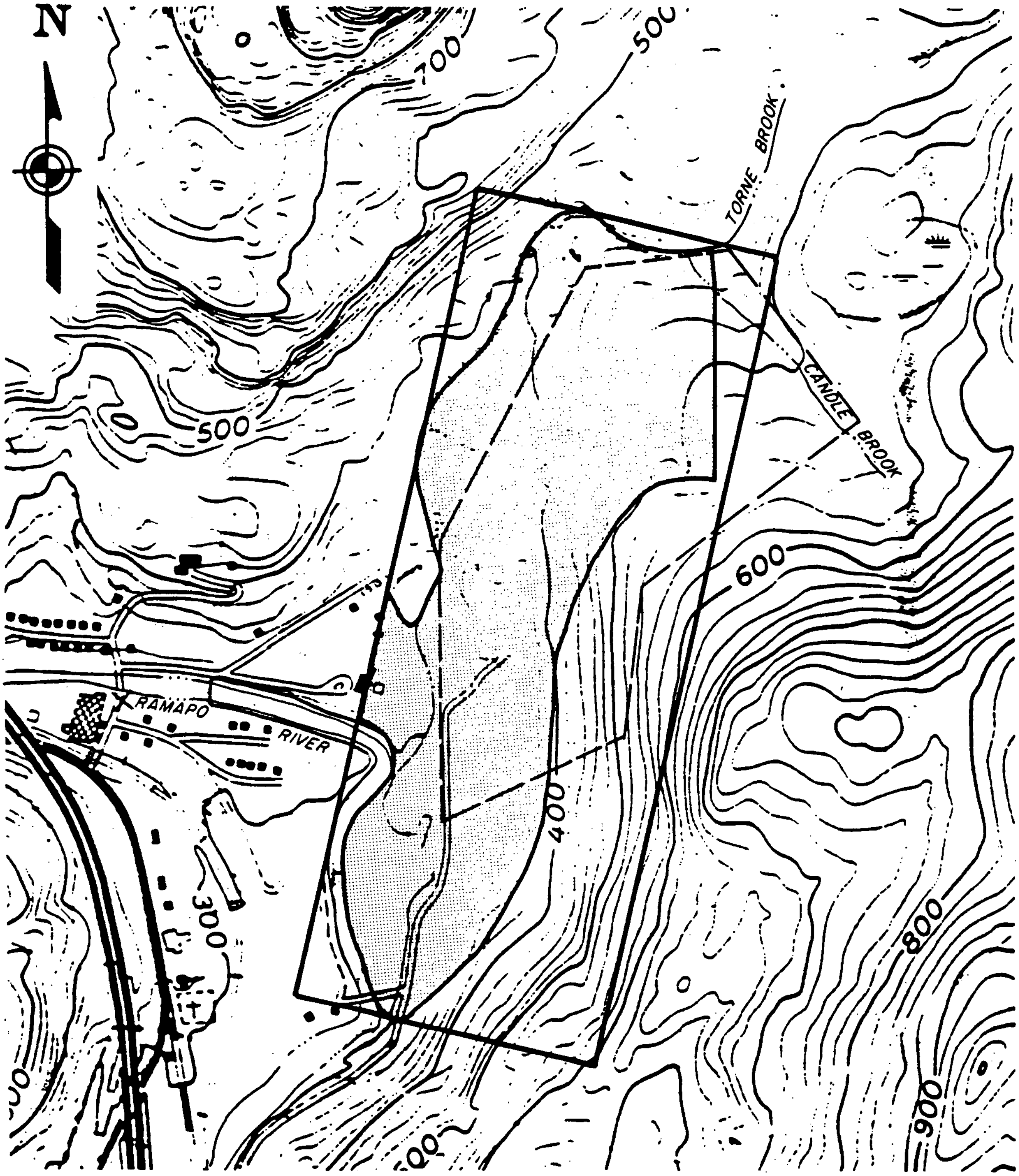
AREAL EXTENT

The areal extent of the model was determined based on the availability of information pertaining to the hydrogeologic conditions of the site and vicinity. The modeled area was situated between Torne Brook, the natural aquifer boundaries, and the Ramapo River as shown on Figure 1. Also, an area west of Torne Brook in the vicinity of well MW-9 was included.

The grid dimensions were 1,800 ft from east to west and 4,800 ft from north to south. The selection of the modeled area was largely dictated by the general objectives of the model. Its main objective was to simulate the conditions in the area adjacent to the Torne Brook in its lower reach. Therefore, the model includes the area surrounding well URS MW-9, west of the Torne Brook. Also, the grid spacing was refined in that region to provide greater accuracy.

FINITE DIFFERENCE CELL CONDITIONS

Conditions in each finite-difference cell in MODFLOW may be set separately to: 1) no-flow 2) general head 3) constant head 4) variable head. A no-flow boundary does not allow flow to cross the model boundary. A general head boundary allows flow to a cell in proportion to the water level specified for an external cell. A constant head cell maintains the water level specified for it. A variable head cell allows the program to



LEGEND

▨ MODELED AREA

┆ LIMITS OF LANDFILL

□ LIMITS OF THE FINITE DIFFERENCE GRID

SCALE 0 500 1000 FEET

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AREAL EXTENT OF THE GROUNDWATER FLOW MODEL

FIGURE 1

determine a hydraulic head in it. All four types were used in the Ramapo Landfill groundwater flow model.

The Ramapo River and the upper reach of Torne Brook were used as constant head cells in Layer 1 (upper aquifer). Also the northern boundary for Layer 1 (a line connecting MW-6, MW-5 and P-1) was assumed to consist of constant head cells. The natural boundary of the aquifer was considered a no-flow boundary with recharge coming from the mountains surrounding the aquifer.

For the Layer 2 (bedrock aquifer), the natural aquifer boundary was also set to no-flow and recharge. All other boundaries are modeled as general head cells.

The locations of the natural aquifer boundaries were assumed after the USGS Open-File Report 82-114 "Geohydrology of the Valley-Fill Aquifer in the Ramapo and Mahwah Rivers Area, Rockland County, New York" (Moore et al, 1982).

EXISTING LEACHATE COLLECTION SYSTEM

The existing leachate collection system is described in Section 1.2.5 of the RI. It consists of a toe drain, an above-ground surface water collector, a shallow subsurface collector and a deep subsurface collector. As discussed in Section 3.7.5 of the RI, portions of the collection system are periodically above the water table making it difficult to estimate quantities collected within these four collectors. The Town has contracted for 80,000 gallons per day (gpd) to be treated at the Village of Suffern Wastewater Plant based on flow rates from their historical records. This equates to approximately 55 gallons per minute (gpm). This rate includes all the surface water and subsurface water collected in the system. Remediation efforts will be compared to this rate. The existing leachate collection system located along the downgradient boundary of the landfill was modeled using the MODFLOW drain package. The conductance of drainage pipes was determined during the calibration process.

TORNE BROOK

In its upper reach adjacent to the site, the Torne Brook was assumed to constitute a water divide for the Torne Valley aquifer, therefore, it was modeled as a constant head boundary (Dunn Geoscience Corp. 1988). However, in its lower reach close to the Ramapo River it was modeled using the MODFLOW river package. This was considered to more accurately reflect the nature of the lower reach since in that area the influence of the Ramapo River becomes more pronounced. Also, since remedial action simulations may likely model withdrawal wells in the immediate area, it will ensure that Torne Brook will not become an infinite source of water for those wells.

RAMAPO RIVER

The Ramapo River was assumed to form a constant head boundary along the southwestern edge of the modeled area. This assumption is justified by the fact that the River, having the lowest water surface elevation in the modeled region, serves only as a receptor of water. This condition can be accurately simulated by the constant head boundary because it excludes the possibility of the constant head cells becoming an excessive source of water.

INFILTRATION FOR EXISTING CONDITIONS

An average infiltration for the aquifer tributary to the Ramapo River (primary aquifer) was assumed as 0.003 ft/day ("Evaluation of Ramapo Valley Well Field Management Techniques by RVAM Simulation", LBG Inc. July 1982).

The infiltration to the section of aquifer tributary to the Torne Brook (secondary aquifer) was unknown at the beginning of simulation and constituted one of the calibrated parameters. This approach was chosen due to the high variability of the site's geomorphology (variable slopes, cover types, presence of gullies) that would make a before-hand assessment difficult.

MODEL CALIBRATION FOR THE EXISTING CONDITIONS

Calibration of the model to existing conditions was achieved through a comparison of measured to simulated water levels in the on and off-site monitoring wells and piezometers. Table 1 provides details of this comparison. The "Best Fit" was achieved using a parameter optimization program (MODINV) with the following parameters being calibrated: horizontal hydraulic conductivity in Layer 1, transmissivity in Layer 2 and vertical conductance between Layers 1 and 2. The optimizing program was run many times using different combinations of recharge, drain conductance and river bed conductance. The resulting values of hydraulic heads differ from those observed in the field by less than 3.0 ft. This was assumed as sufficient accuracy, since the hydraulic head difference across the site was about 220 ft. This corresponds to the difference between calibrated and observed values being about 1.4% of the maximum head difference across the site.

The final values of optimized parameters are as follows:

- Layer 1
  - Primary aquifer Kh = 3-9 ft/day
    Kv = 0.3 - 0.9 ft/day
  - Secondary aquifer Kh = 0.1 - 0.3 ft/day
    Kv = 0.01 - 0.03 ft/day
  - Waste Kh = 0.04 - 0.3 ft/day
    Kv = 0.004 - 0.03 ft/day

TABLE 1

MONITORING LOCATION	LAYER NO.	OBSERVED HEADS	MODELED HEADS	ABSOLUTE VALUE OF HEAD DIFFERENCE	PERCENT OF MAXIMUM HEAD DIFFERENCE ON SITE
		[FT]	[FT]	[FT]	[%]
MW - 1	1	362.70	363.17	0.47	0.21
MW - 2	1	410.90	410.92	0.02	0.01
MW - 3	1	333.20	330.57	2.63	1.18
MW - 4	1	446.00	447.00	1.00	0.45
MW - 7	1	299.20	299.55	0.35	0.16
MW - 8	1	306.20	306.30	0.10	0.05
MW - 9	1	302.00	303.09	1.09	0.49
P - 2	1	515.00	513.51	1.49	0.67
P - 3	1	391.70	392.93	1.23	0.55
P - 4	1	386.50	387.72	1.22	0.55
P - 5	1	390.90	390.14	0.76	0.34
P - 6	1	321.60	319.68	1.92	0.86
P - 8	1	307.90	308.67	0.77	0.35
MW - 2	2	407.90	406.29	1.61	0.73
MW - 3	2	332.40	332.81	0.41	0.18
MW - 4	2	440.80	438.55	2.25	1.01
MW - 7	2	295.60	296.92	1.32	0.59
MW - 8	2	307.30	308.89	1.59	0.72
MW - 9	2	297.00	295.86	1.14	0.51

- Layer 2

  Kh = 0.048 - 0.056 ft/day

  Kv = 7E-7 - 12E-7 ft/day.

The calibrated values are generally in agreement with the field measurements. They have been converted to cm/sec from ft/day and are as shown in Table 2.

TABLE 2

	Kh Calibrated [CM/S]	Kh Measured [CM/S]
Layer 1 (Primary Aquifer)	1E-3 - 3E-3	1E-4 - 1E-2
Layer 1 (Secondary Aquifer)	0.3E-4 - 1E-4	4E-5 - 2E-3
Layer 2	1.6E-5 - 2E-5	9E-6 - 1E-2

GENERAL FLOW REGIME

- The calibrated model is considered to be representative of generalized conditions at the site.

- Upper Aquifer (Layer 1)

  Across the modeled area, lateral flow is generally concurrent with the slope of the terrain towards Torne Brook as shown on Figure 2. Torne Brook is a topographic low between the landfill and the land between the brook and the Ramapo River. Much of the flow in the overburden is intercepted by the leachate collection system along Torne Valley Rd.

  In the southern portion of the modeled area, flow is directed towards the Ramapo River.

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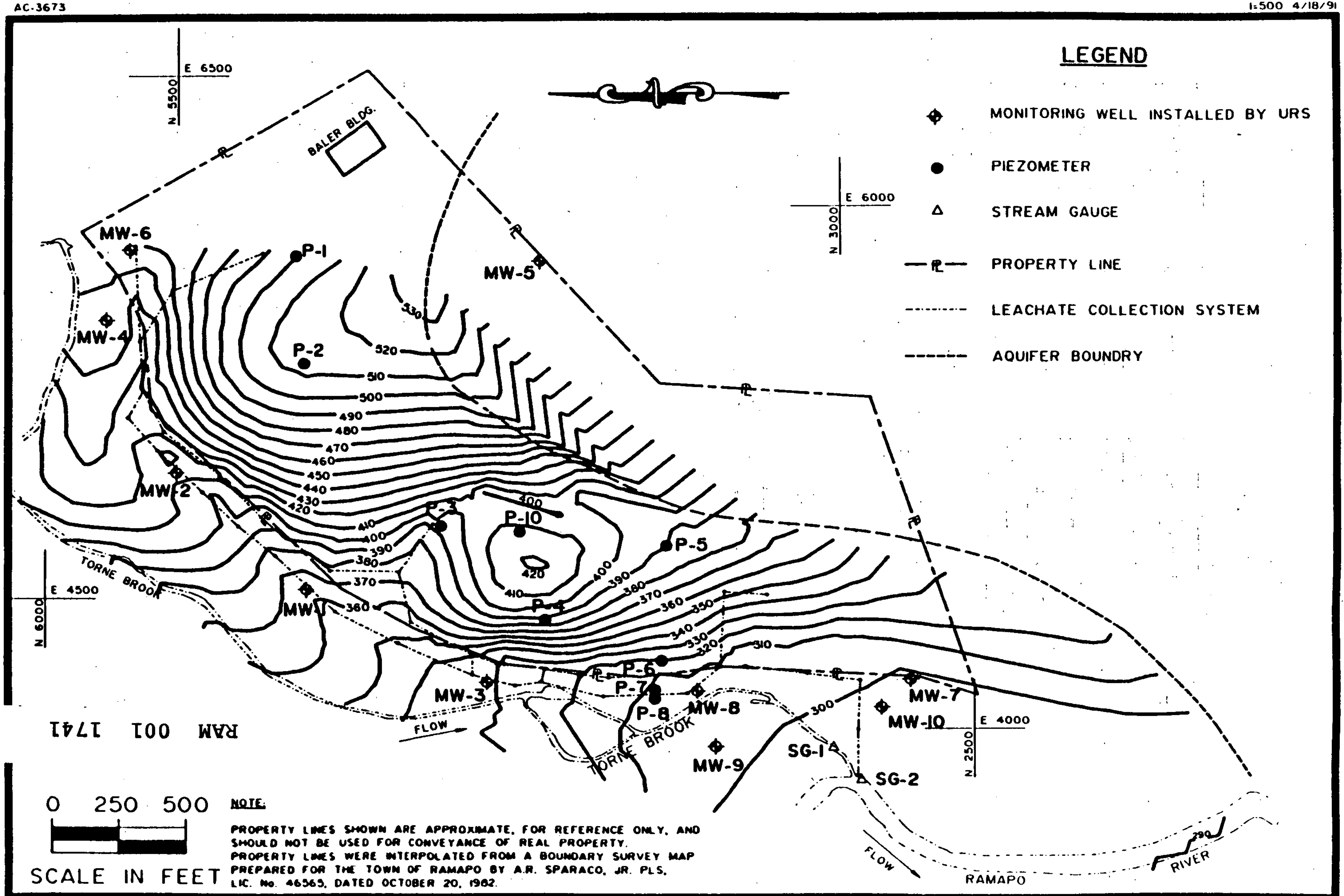

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SIMULATION ONE
HYDRAULIC HEADS IN LAYER ONE

FIGURE 2

- Bedrock Aquifer (Layer 2)

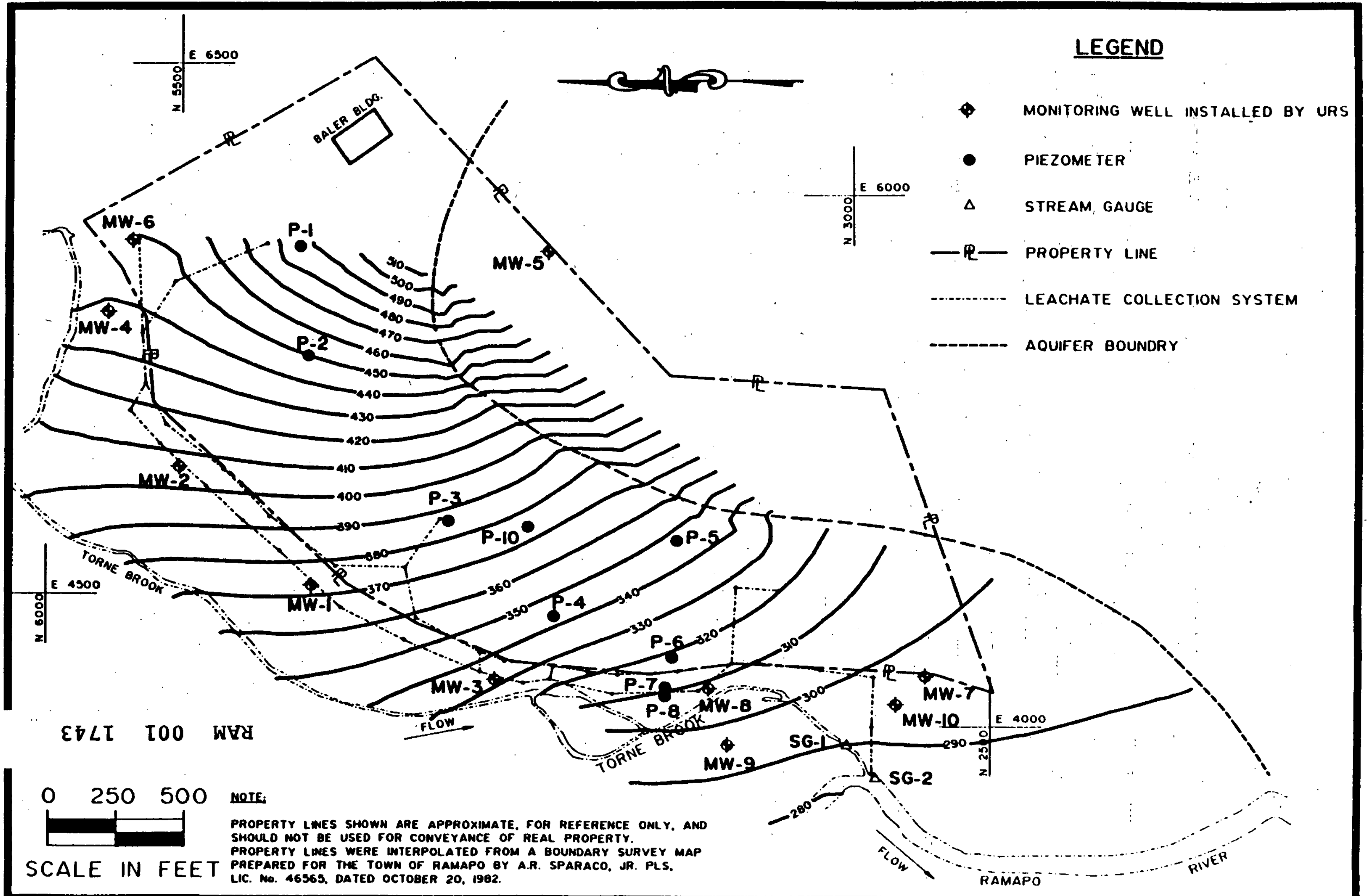
  In the bedrock aquifer, flow is directed from the mountains towards the Ramapo River as shown on Figure 3. It is not influenced by Torne Brook or the leachate collection system.

- Vertical Flow

  The very low vertical conductance obtained from the calibration process suggests that the two aquifers are not hydraulically connected. However, since the fractured bedrock was modeled as a porous media, vertical flow has to be regarded as an areal average. In reality it takes place through sparsely distributed fractures in the bedrock and its real velocity is much greater than the one suggested by the average flow. This is of significant importance in considering the migration of contaminants offsite, for which the real flow velocity will have to be obtained by considering the effective porosity of the fractured bedrock.

  Throughout most of the site, the hydraulic heads in the upper aquifer are greater than in the bedrock aquifer. This creates downward flow by which the contaminated leachate from the waste layer can potentially enter the bedrock aquifer. Small areas of the upward flow occur in the vicinity of URS MW-8 and MW-10 and were recreated by the model.

The summary of the parameters resulting from the calibration process and the hydrogeology of the site is presented below.



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SIMULATION ONE
HYDRAULIC HEADS IN LAYER TWO

FIGURE 3

	Layer 1 (Upper Aquifer)			Layer 2 (Bedrock Aquifer)
	Primary	Secondary	Waste	
Kh [CM/S]	1E-3 - 3E-3	0.3E-4 - 1E-4	1.4E-5 - 1E-4	1.6E-5 -2E-5
Kv [CM/S]	1E-4 - 3E-4	0.3E-5 - 1E-5	1.4E-6 - 1E-5	7E-7 - 12E-7
Saturated Thickness [ft]	10-30	10-30	up to 60	25
Recharge [in/yr]	13.1	4.4	22-44	NA

The parameters are considered to be representative of steady state conditions at the site. The calibrated model was used as the baseline for comparisons between remedial technologies. In evaluating remedial technologies, all uncertainties and sensitivities inherent in looking at one remedial technology would therefore be applied to all technologies. Remedial technologies selected in the Feasibility study were superimposed on the groundwater flow system to evaluate their impact and effectiveness for long-term, steady-state conditions.

MODEL SIMULATIONS OF REMEDIAL TECHNOLOGIES

The purpose of this study was to assess the effect of implementing remedial technologies at the site. The remedial technologies considered were: surficial cap, withdrawal wells, and improvements to the leachate collection system. They were simulated in different combinations in order to achieve the following groundwater-related objectives.

- Prevent or reduce offsite contaminant migration via upper aquifer.
- Prevent or reduce offsite contaminant migration via the bedrock aquifer.

- Minimize the amount of groundwater to be collected and treated.

The simulations were performed for steady-state conditions.

INFILTRATION FOR CAPPED CONDITIONS

In order to evaluate the influence of capping the site with either a NYS Part 360 cap or soil cap on the regional flow patterns and leachate quantities, an infiltration analysis was performed using the Hydrologic Evaluation of Landfill Performance (HELP) computer model. The model was developed by the United States Army Corps of Engineers Waterways Experiment Station for the USEPA (Schroeder, et al, 1984). It simulates water movement within landfills employing a quasi-two-dimensional approach. Its solution technique accounts for the effects of surface runoff, infiltration, percolation, evapotranspiration, soil moisture storage and lateral drainage. The model offers a choice of user-generated input or default values.

The HELP model was applied to the site using default climatological data for the 5-year simulation period from 1975 to 1979. Edison, New Jersey weather station was used, being the closest location to Ramapo for which a set of default climatological data was available.

The model allows for four types of layers: vertical percolation (topsoil, wastes), lateral drainage (sand), barrier soil (clay) and barrier soil with liner (such as HDPE). Soil parameters can be either user-generated or program-generated (default).

The Part 360 cap was modeled as follows:

Layer Description	Thickness	Layer Type for Modeling Purposes
Topsoil	6"	Vertical percolation
Fill	24"	Vertical percolation or lateral drainage
Sand	12"	Lateral drainage (optional)
Clay	18"	Barrier soil (with and without liner)
Waste		Waste

Also, a potential impact of a gas venting layer consisting of 12 inches of sand was investigated.

Input parameters required for defining the layers include: thickness, hydraulic conductivity, porosity, field capacity, wilting point and initial water content. As specific details of a cap design are not finalized, default values suggested by the model documentations were used.

The following values were obtained based on the HELP simulations for capped conditions:

	Inches/Year	% of Yearly Rainfall
Runoff	0.5-8.4	1-16%
Evapotranspiration	31.3-33.9	60-65%
Lateral Drainage	6.3-18.8	12-36%
Infiltration	3.1-3.7	6-7%

The results indicate, that the amount of rainwater that would infiltrate through the cap and reach the groundwater will be reduced to 3.1-3.7 inches per year from the approximate 50 inches/yr which precipitates in areas without a liner. And it be reduced to 0.5 inches/yr in areas with a liner. The infiltration for existing conditions, based on the results of the calibrated groundwater model, displays a very high displays a very high spacial variability. Throughout most of the site existing infiltration ranges from 4.4 inches per year in the areas of dense sands to 13.1 inches per year in the areas of loose sands. In several locations, however, it reaches 22 to 44 inches per year. This is due primarily to two factors: high permeabilities of refuse in the unvegetated portions of the landfill and the accumulation of offsite surface water runoff in the flatter areas. Locations of high infiltration areas are: the northern and southern lobes and the gully behind the southern lobe.

For a soil cap, which consists of the same HDPE membrane over the northern and southern lobes, and soil covering the sideslopes of the landfill, the following was estimated. Infiltration through the sideslopes would be similar to existing conditions, as a general fill material would be used, and the grading plan for the most part would remain the same. Infiltration through the HDPE would be equivalent to the Part 360 cap on the lobes.

SIMULATION 1 - Existing Conditions

The purpose of this simulation was to establish the regional flow pattern and point out the problem areas. The results indicate that most of the offsite flow is intercepted by the deep collector within the overburden aquifer. However, portions of the deep collector are periodically exposed above the water surface. In the vicinity of wells MW-8, MW-3, MW-4 and MW-6 the water is draining from the deep collector and flowing underneath to Torne Brook. The estimated leachate collection rate in the deep collector is 29 gpm. The estimated amount of surface water collected in the shallow subsurface collector and the surface water collector is therefore 26 gpm. The simulated water table is shown on Figure 2; the simulated potentiometric surface for the bedrock aquifer is shown on Figure 3.

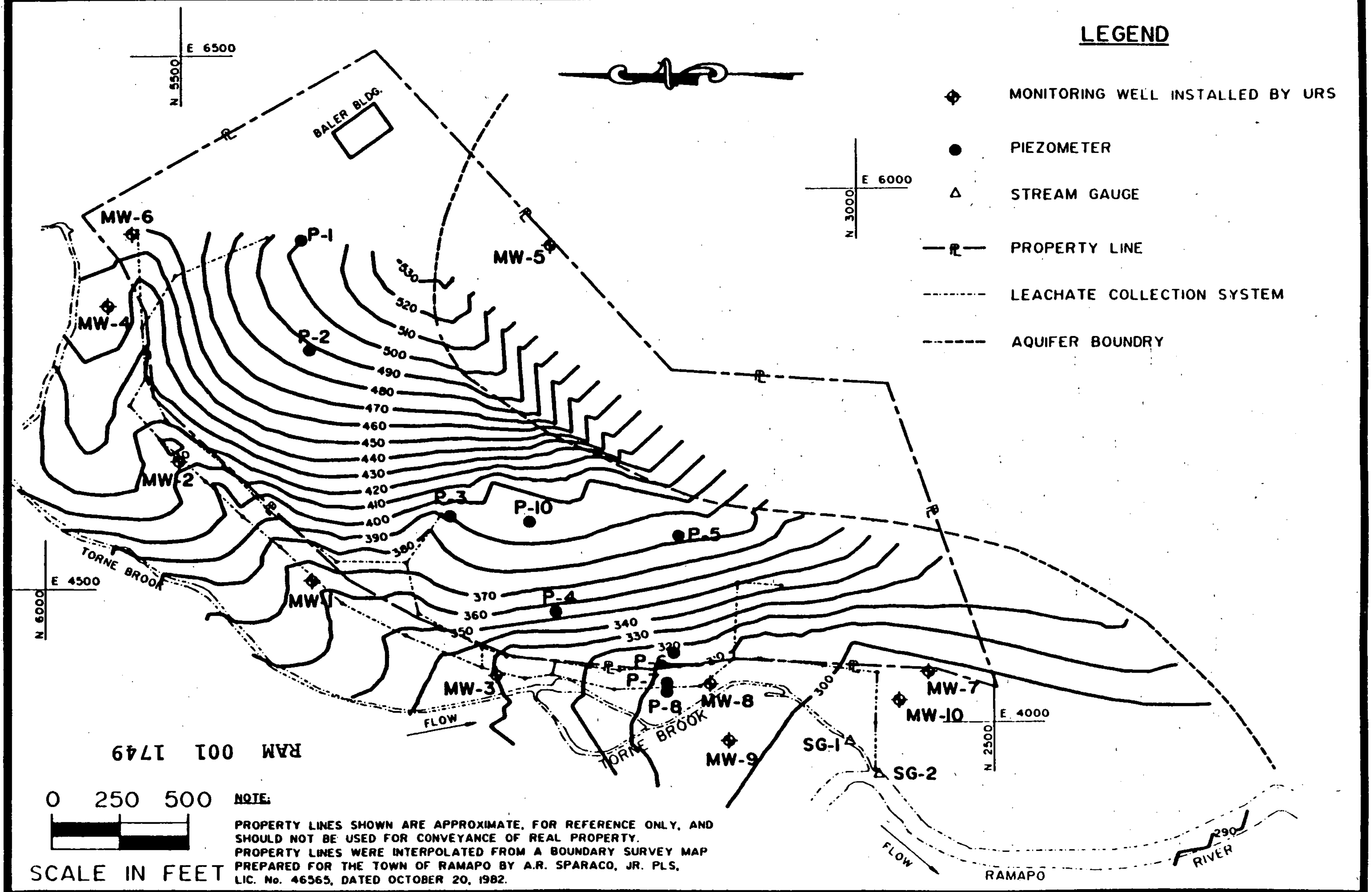
SIMULATION 2 - Existing Drainage System, Site Capped

This simulation shows how capping the site with a Part 360 cap influences the flow patterns and leachate rates. A decrease in infiltration causes significant lowering of the water table across the entire site within the overburden aquifer. The volume of leachate being intercepted by the leachate collection system decreases as well from 29 gpm to 16 gpm. Also, the downward migration of contaminated water from the waste layer to the bedrock aquifer decreases due to the significant drop in the vertical gradients. All surface water runoff is diverted offsite.

The migration of the contaminated groundwater via the overburden aquifer underneath the exposed collectors continues as in Simulation 1. However, more pipes are exposed, especially the shallow collector in the vicinity of wells MW-2 and MW-1, which accentuates the problem. The simulated water table is shown on Figure 4.

SIMULATION 3 - Natural Infiltration, Withdrawal Wells In The Areas of Exposed Drains

This simulation models the combination of technologies in which nine withdrawal wells placed along the lower reach of the Torne Brook were used to intercept contaminated groundwater bypassing the exposed drains and flowing towards the lower reach of the Torne Brook. All drains in the vicinity of the withdrawal wells became exposed; however, flow of the contaminated groundwater towards the Torne Brook was reversed. The withdrawal rates necessary to achieve this result are: wells - 51 gpm and drains - 24 gpm.



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SIMULATION TWO
HYDRAULIC HEADS IN LAYER ONE

FIGURE 4

SIMULATION 4 - Site Capped, Withdrawal Wells In The Areas Of Exposed Drains

This simulation follows the setup of Simulation 3, however, instead of the natural infiltration, Part 360 capped conditions were used. Nine withdrawal wells placed along the lower reach of the Torne Brook reverse the direction of flow in the area of exposed collectors, intercepting contaminated groundwater before it reaches Torne Brook. As the water table onsite is lowered through capping, the withdrawal rates needed to reverse the flow direction are much lower than in Simulation 3: 14 gpm for wells and 14 gpm for drains.

SIMULATION 5 - Existing Conditions, Well PW-1 in Operation

This simulation models the existing conditions onsite with the private well PW-1 on an adjacent property in operation. Downward vertical gradients were observed in MW-9 cluster located on the adjacent property owner's land. In order for landfill contaminants to enter PW-1, which is a dug well in the overburden, upward vertical gradients must exist between the bedrock and the overburden. Under natural conditions this was not considered to be feasible given the localized influence of the Ramapo River. However, under pumped conditions this was considered potentially feasible. The purpose of the simulation was to determine whether PW-1 could have a significant influence on the vertical gradients in its vicinity.

A simulation was performed for the steady state withdrawal rate of 4,500 gpd based on 50 users at 90 gpd (Clark, et al, 1977). It indicates that the well's effect on flow patterns in its vicinity is negligible.

SIMULATION 6 - Site Capped, 2 Withdrawal Wells in the Northern Portion of the Site in the Vicinity of Torne Brook

This simulation was designed to evaluate the possibility of installing withdrawal wells in the northern portion of the site as a means of preventing contaminant migration in that direction. The results indicate that because of the low hydraulic conductivity and small thickness of the aquifer in this area, the expected yields will be very low, that is, not sufficient to reverse the flow direction. Therefore, a leachate collection system may have to be installed in order to prevent offsite contaminant migration in that area. A Part 360 cap was used.

SIMULATION 7 - Site Capped, Elevations of Drains Lowered, New Drains Added on Southern End of the Site, Withdrawal Wells in Both Lower and Upper Aquifer

The purpose of this simulation was to investigate the possibility of a total elimination of the offsite flow. To achieve this objective, the following remedial measures were simulated:

- Part 360 Cap
- Drain elevations in problem areas were lowered
- New drains were introduced
- Withdrawal wells in the lower and upper aquifer were modeled.

The results of the simulation indicate that it is possible to eliminate offsite flow. However, for the bedrock aquifer the effectiveness of the withdrawal well system would strongly depend on the nature of fractures. It is possible that some of the modeled well locations would have to be eliminated due to the aquifer's inability to supply water. The withdrawal rates needed to achieve the remedial objectives are: wells - 9 gpm, drains - 33 gpm.

SIMULATION 8 - Existing Drainage System, Site Capped (Soil Cap and HDPE Liner)

This simulation was performed in order to assess the influence of a soil cap/HDPE liner combination on the flow patterns and leachate rates. The soil cap, covering about 45 acres, allows for the natural level of infiltration. The HDPE liner significantly decreases the infiltration in the areas of the southern and northern lobes (about 25 acres).

A sharp drop in water level (up to 25 feet) can be observed within the overburden in the areas covered by the HDPE liner. The volume of leachate being intercepted by the leachate collection system decreases from 29 gpm to 14 gpm. Also, a significant decrease in the magnitude of downward flow can be observed due to the drop in the vertical gradients. The migration of the contaminated groundwater via the overburden aquifer underneath the exposed collectors continues as in Simulation 1. The modeled water table is shown on Figure 5.

SOLUTE TRANSPORT

In order to evaluate the potential for offsite migration of contaminants from the Ramapo Landfill to the potential receptor identified as PW-1, a contaminant transport analysis was performed. The model was based on the field observations and measurements gathered during the Remedial Investigation and the results of the groundwater flow model discussed previously.

APPROACH

The model follows a step-by-step approach in attempting to trace the propagation of contaminants from the onsite fill to PW-1.

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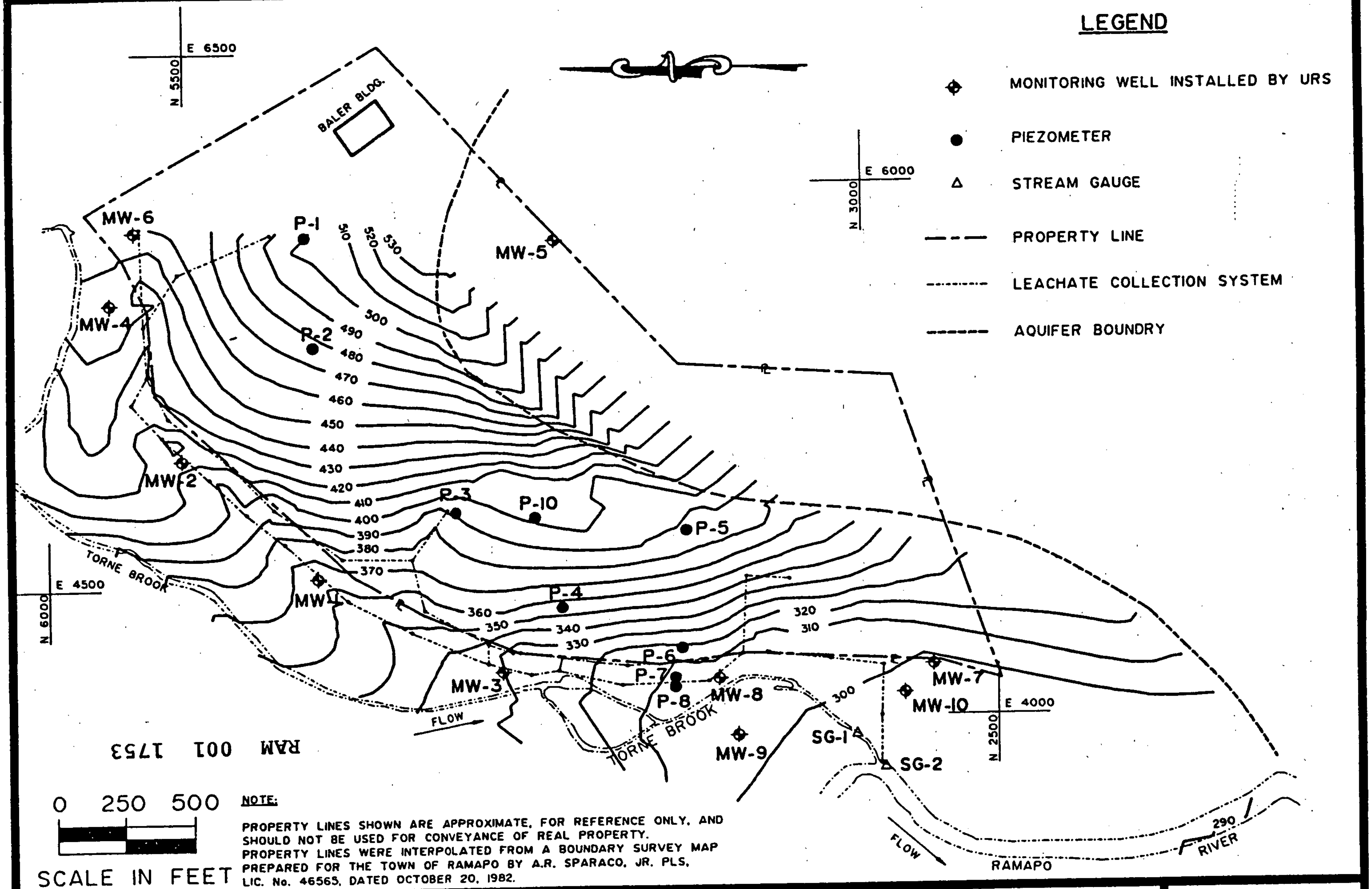

NOTE:

PROPERTY LINES SHOWN ARE APPROXIMATE, FOR REFERENCE ONLY, AND SHOULD NOT BE USED FOR CONVEYANCE OF REAL PROPERTY. PROPERTY LINES WERE INTERPOLATED FROM A BOUNDARY SURVEY MAP PREPARED FOR THE TOWN OF RAMAPO BY A.R. SPARACO, JR. PLS, LIC. No. 46565, DATED OCTOBER 20, 1982.

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SIMULATION SEVEN
HYDRAULIC HEADS IN LAYER ONE

FIGURE 5

- First, the groundwater contour maps generated by the flow model are analyzed in order to determine the pathways by which the contaminants can reach PW-1
- Second, the propagation of contaminants along those pathways is traced using analytical methods of calculation.

The analytical techniques used include calculating the contaminant concentration using a steady-state 1-Dimensional mass balance and the 1-Dimensional, transient convective-dispersive equation.

Also, the effects of pumping in well PW-1 are estimated based on the constant discharge, transient, unconfined case.

DETERMINATION OF CONTAMINANT MIGRATION PATHWAYS

The results of the groundwater flow model provided a basis for the contaminant transport model. Simulation 1 was used as representative of existing conditions to determine the groundwater flow patterns in the area.

- Upper Aquifer

  Groundwater from the landfill is flowing west towards Torne Brook and then turns south flowing to the Ramapo River. It is either intercepted by Torne Brook (in the areas where it constitutes a water divide) or is directed towards the Ramapo River. Well PW-1, located on the opposite side of the Brook than the landfill, is not influenced by that flow. Therefore, the flow pattern and lack of significant contamination in MW-90/S indicates that the contamination of PW-1 via the upper aquifer is very unlikely.

- Vertical Flows

  Very high downward hydraulic gradients exist over the entire landfill area, causing a potential for migration of contaminated leachate from the landfill to the underlying fractured bedrock. The magnitude of the downward flow was determined based upon the maximum head difference of 60 ft and the vertical conductance of 2E-7 ft/day. (Parameters were determined by the groundwater model.) The obtained value is 1.2E-5 ft/day.

- Bedrock Aquifer

  The flow pattern in the bedrock aquifer, as determined by the groundwater model, indicates that groundwater flow is away from the natural aquifer boundaries (mountains) towards the Ramapo River. Groundwater passes underneath the landfill, receiving the contaminated leachate due to the downward flow existing over that area. As Torne Brook does not influence flow within the bedrock aquifer, the contaminated water moves southwest and can potentially reach the area of PW-1. The average magnitude of flow within the bedrock aquifer, as determined by the groundwater flow model, is 0.13 ft^2/day.

- Vertical flows in the vicinity of PW-1 well

  Well PW-1 is a dug well in the overburden and provides potable water for Torne Brook Estates for about 50 people. Assuming the water consumption of 90 gpd (Clark, et al, 1977), the average daily flow is 4500 gpd. Simulation 5 of the groundwater flow model indicates that for steady-state conditions this is not sufficient to cause upward flow from the bedrock aquifer to the overburden. However, the analytical calculations of well drawdown for the nonsteady-state indicate that upward flows are possible for certain sets of pumping conditions. Since the exact data for the well's operation is not available, it was assumed that this possibility had to be investigated.

CALCULATION OF CONTAMINANT CONCENTRATIONS

The potential migration pathways were determined in the previous section based on the results of the groundwater flow model and the analysis of the operation of well PW-1. The contaminant concentration along these pathways was described using the analytical techniques and utilizing the aquifer parameters obtained both from the calibrated groundwater model and the RI field investigation.

o Bedrock aquifer directly underneath the landfill
As determined earlier, there is a potential for leachate from the Ramapo Landfill to enter the underlying bedrock aquifer. The vertical velocity was estimated at 1.2E-5 ft/day. The contaminant concentration within the leachate was conservatively assumed to be equal to that directly in the landfill. The accumulation of the pollutant in the bedrock aquifer was modeled utilizing a 1-Dimensional steady-state mass balance approach, with the contaminated leachate treated as a distributed source over the length of 1500 ft. The results indicate the concentration of the contaminant in the groundwater within the bedrock aquifer at the downgradient end of the landfill of about 12% of the leachate concentration.

o Bedrock aquifer from the downgradient end of the landfill to PW-1
In this area, contaminant propagation was modeled utilizing a 1-Dimensional transient convective-dispersive equation (Bear, 1979). The downgradient end of the landfill was assumed as a starting point and PW-1 500 ft to the west was the ending point of the simulation. The properties of the aquifer were assumed after the field investigation findings for two wells in the immediate vicinity: URS MW-8 and URS MW-9. The average hydraulic conductivity of the bedrock based on the slug and pressure tests is 8E-4 cm/s, and the hydraulic gradient determined from monitoring levels in MW-8 and

MW-9 is 0.025 ft/ft. The porosity of the fractured bedrock was assumed as 5% which is an average value for fractured crystalline rock as given in "Groundwater and Wells" (Driscoll, 1987). Those parameters give an average effective velocity of the groundwater flow of 1.15 ft/day. Different values of the hydrodynamic dispersivity were used ranging from 1 meter to 100 meters (Freeze & Cherry, 1979). This was assumed to cover the possible range of values of this parameter, as no information pertaining to actual field values were available. The initial concentration of the contaminant at the starting point was assumed as 12% of the concentration in the landfill from the previous section.

The results of the model indicate that the concentration of contaminant at the ending point (directly underneath PW-1) reaches the steady-state concentration equal to that of the starting point (downgradient edge of the landfill) after 2 - 10 years, depending on the value of the hydrodynamic dispersivity used. Since the landfill has been operational for a much longer period of time, it can be assumed that the concentration of contaminant is the bedrock beneath PW-1 is equal to about 12% of the concentration of the contaminant in the landfill.

o Assessment of the contamination of well PW-1

As mentioned earlier, the steady-state withdrawal rates in well PW-1 are sufficient to cause upward flow. The influence of the nonsteady pumping was also investigated.

The hydrogeology in the immediate vicinity of PW-1 was based on the boring log from MW-9, about 250 ft from PW-1. The thickness of the saturated zone in the upper aquifer is about 32 ft. Since the formation consists of both dense and loose sands, the average hydraulic conductivity of 10 ft/day was used based on the groundwater model. The effective porosity was assumed as 30% (Ref. Bear, 1979).

Using the formula for the drawdown in a pumping well screened in an unconfined aquifer, the vertical gradients were evaluated for different pumping conditions (Bear, 1979). It was determined that upward flow from the bedrock will start for pumping cycle of 15 gpm over 67 minutes. (A cycle was assumed to last as long as it takes to fill up a 1000 gallon tank, e.g., for a cycle of 20 gpm over 50 minutes, the contribution of the bedrock water will create a contaminant concentration in the well water of about 6E-5 of the concentration in the landfill reduction of 5 orders of magnitude.)

SUMMARY

Based on the results of the contaminant transport model, the following conclusions can be made:

- Downward gradients prevail across the site and the contaminated groundwater from the landfill is infiltrating into the lower (bedrock) aquifer. Therefore, the bedrock aquifer underneath the landfill provides the potential for contaminant migration. As there is no barrier restricting groundwater movement within the bedrock aquifer, the contamination may migrate towards residential well PW-1 and the Ramapo River. It is estimated that at the present time, groundwater within the bedrock aquifer beneath well PW-1 contains a contaminant concentration of about 12% of that directly within the landfill.

- Estimated withdrawal rates in well PW-1 are too small to cause significant upward flow from the bedrock aquifer. It was estimated that, depending on the withdrawal rates assumed, the concentration of contaminants in PW-1 can vary from zero to 6E-5 times the concentration of contaminants within the waste area. Therefore, it is questionable whether well PW-1 is actually being impacted by the contaminants in the bedrock aquifer.

Data for Contaminant Transport Model

	Upper aquifer	Bedrock aquifer
Horizontal Hydraulic Conductivity [cm/s]	3.5×10^{-3}	1.8×10^{-5} 8.0×10^{-4}
Vertical Hydraulic Conductivity [cm/s]	3.5×10^{-4}	4.4×10^{-10}
Effective Porosity [%]	30	5
Unit Saturated Thickness [ft]	variable	25
Horizontal Hydraulic Gradient [ft/ft]	variable	0.025 - 0.1
Dispersivity [ft]	not used	3.3 - 330

Difference in Hydraulic Heads between aquifers - 60 ft

DATA FOR CONTAMINANT TRANSPORT MODEL - (Continued)

Well PW-1

Discharge [gmp]	5 - 25
Time of a withdrawal cycle [min]	200 - 40
Diameter [ft]	2

Contaminants

Contaminant type	Generic
Molecular diffusivity	Not used
Adsorption coefficient	Not used
Initial solute conc. on site	Generic

Temporal

Vertical flow from the upper to the lower aquifer	Steady-state
Horizontal flow and cont. transport	Transient to steady-state
Operation of well PW-1	Transient

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1.) General Comments

A purpose of this calculation will be to estimate and describe the propagation of contaminants from the landfill area towards a residential well PW-1. The contaminants can reach that well via lower or upper aquifer. Since the flow regimes in those two aquifers differ significantly, they will be treated separately.

2.) Upper Aquifer
The area of concern is situated in the immediate vicinity of the Torne Brook which most probably serves as a groundwater divide for the upper aquifer. The well PW-1 is situated west of the Torne Brook while the landfill itself is situated east of the Torne Brook. The flow pattern in the area adjecent to the lower reach of the brook indicates that groundwater is flowing towards the Torne Brook and than turns south towards the Ramapo River. This flow pattern is very unlikely to produce groundwater movement from the landfill area towards the well PW-1. the groundwater flow model indicates that most of the flow from the site is intercepted by the Torne Brook and the remaining portion is directed towards the Ramapo River. Therefore; the contamination of well PW-1 via the shallow aquifer is considered unlikely.

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3.) Bedrock Aquifer.

The flow pattern in the bedrock aquifer indicates the groundwater movement away from the natural aquifer boundries and turning south towards the Ramapo River. The Torne Brook does not influence this flow pattern. The direction of flow indicates the possibility of the contaminants migrating from the landfill area, underneath the Torne Brook towards the well PW-1.

The following approach will be assumed in trying to estimate the magnitude of contamination:

- The flow of contaminated water from the upper aquifer (waste layer) to the lower aquifer within the landfill will be estimated
- Based on that, the accumulation of the contaminant in the lower (bedrock) aquifer underneath the landfill will be evaluated
- The concentration at the downstream end of the landfill will be assumed as a boundry of specified value
- The migration of contaminants from that boundry downstream towards the well PW-1 will be traced.

The aquifer parameters as well as the flow patterns will be assumed after the results of field investigations and the calibrated groundwater model.

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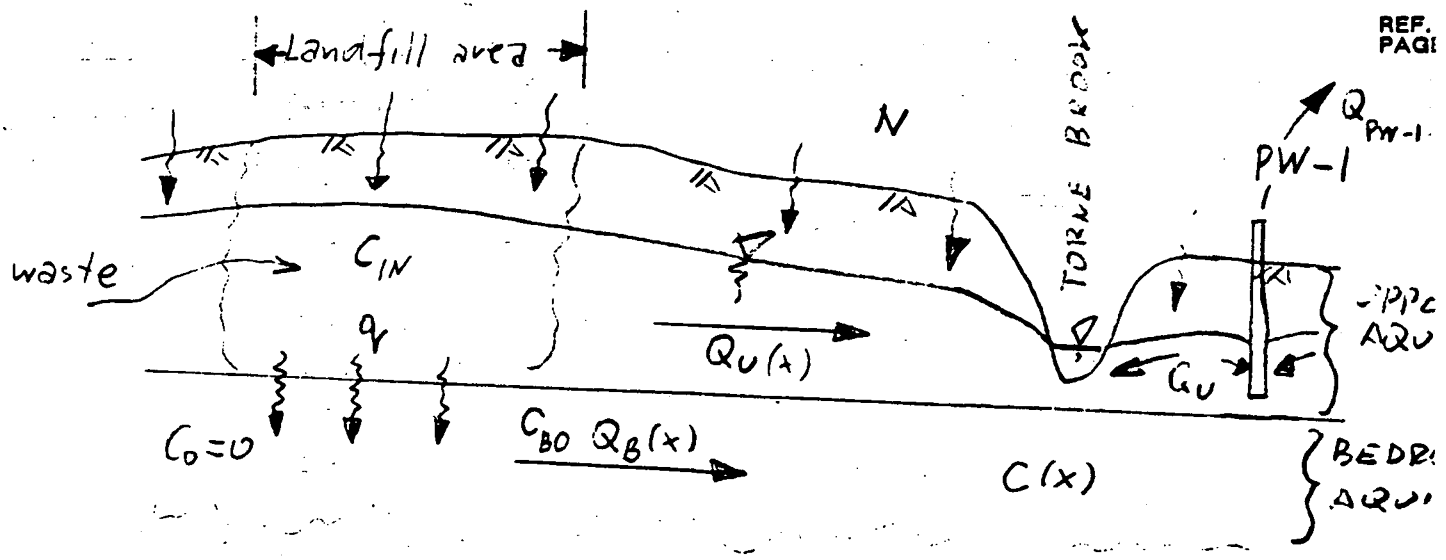

q - leachate rate from the landfill to the bedrock aquifer
Q_B - flow within the bedrock aquifer
Q_u - flow within the upper aquifer
N - recharge
C_{IN} - concentration of the contaminant in the waste layer
C_{BO} - Concentration of the contaminant within the bedrock aquifer at the downstream end underneath the landfill
$C(x)$ - concentration of the contaminant at distance "x" from the downstream end of the landfill (within the bedrock aquifer)

Flow $Q_B(x)$ will be assumed as increasing underneath the landfill and than constant. Recharge q will be assumed constant.

A) Contaminant transport underneath the landfill, within the bedrock aquifer.

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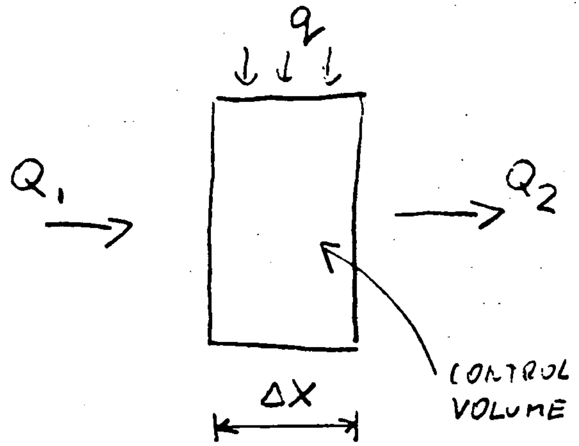
- FLOW underneath the landfill within the bedrock aquifer



$$Q_2 - Q_1 = q\Delta x$$

$$\Delta Q = q\Delta x$$

$$\frac{\Delta Q}{\Delta x} = q$$

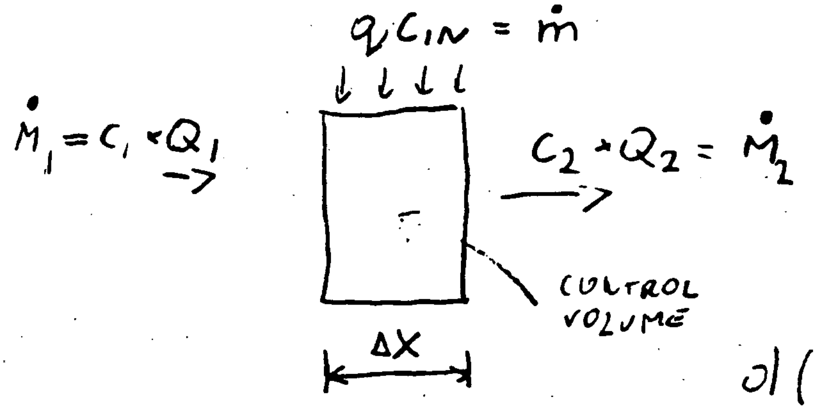
$$\frac{dQ}{dx} = q$$

$$Q = qx + C \qquad \begin{matrix} x=0 \\ Q=Q_0 \end{matrix}$$

$$Q_0 = q\cdot 0 + C$$
$$C = Q_0$$

$$\underline{\underline{Q(x) = qx + Q_0}}$$

- Contaminant accumulation within the bedrock aquifer, underneath the landfill.



$$\dot{M}_2 - \dot{M}_1 = \dot{m}\Delta x$$

$$\frac{d\dot{M}}{dx} = \dot{m}$$

$$\frac{d(QC)}{dx} = qC_{IN}$$

$$Q\frac{dc}{dx} + C\frac{dQ}{dx} = qC_{IN}$$

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$$Q(x) = Q_0 + q x$$

$$(Q_0 + q x)\frac{dc}{dx} + qc = q c_{in} \qquad /:(Q_0 + q x)$$

$$\frac{dc}{dx} + \frac{q}{Q_0 + q x} c = q c_{in} / (Q_0 + q x)$$

This eq is of the form

$$\frac{dc}{dx} + P(x) c = Q(x)$$

$$P(x) = q / (Q_0 + q x) \quad , \quad Q(x) = c_{in}\, q / (Q_0 + q x)$$

and can be solved using an integrating factor

$$\phi(x) = \exp\left(\int P(x)\, dx\right) =$$

$$= e^{\int \frac{q}{Q_0 + q x} dx} = e^{\ln(Q_0 + q x)} = Q_0 + q x$$

$$\frac{d}{dx}\left[c\,\phi(x)\right] = Q(x)\,\phi(x)$$

$$\frac{d}{dx}\left[c \cdot (Q_0 + q x)\right] = \frac{q c_{in}}{Q_0 + q x} \cdot (Q_0 + q x)$$

$$c(Q_0 + q x) = \int q c_{in}\, dx$$

$$c(Q_0 + q x) = q c_{in} x + A$$

$$c(x) = \frac{q c_{in} x + A}{Q_0 + q x}$$

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Boundry Condition:

$$x = 0 \rightarrow c = C_o$$

$$C(0) = C_o = \frac{A}{Q_o}$$

$$A = C_o Q_o$$

Final solution is

$$C(x) = \frac{q C_{in} x + Q_0 C_0}{Q_0 + q x} \quad (1)$$

Values of coefficients assumed after the groundwater model

$$- \quad q = \frac{\phi_{UPPER\ AQ} - \phi_{BEDROCK\ AQUIFER}}{\frac{THICKNESS\ U-B}{VERTICAL\ COND.}}$$

$$(\phi_U - \phi_B)_{AVG} = 60\ ft \quad (\text{SEE SHEETS } 28, 29)$$

$$\frac{VERT.\ CON}{THICNESS} = 2E-7\ 1/day \quad (\text{GW MODEL})$$

$$q_{AVG} = 60 \times 2E-7 \quad \left[FT \cdot \frac{1}{DAY} = FT/DAY \right]$$

$$q_{AVG} = 1.2\,E-5\ ft/day$$

$$- \quad Q_0 = T_{BEDROCK\ AQ} \times i$$

$$T_{AVG} = 1.3\ ft^2/day \quad (\text{GW MODEL})$$

$$i_{AVG} = 0.1 \quad (\text{SEE SHEET } 29)$$

$$Q_0 = 1.3 \times 0.1 \quad \left[FT^2/DAY \right]$$

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$$Q_0 = 0.13 \ ft^2/day$$

- C_0 assumed as zero (entering water assumed clean)

- Length of the flow path underneath the landfill assumed to be

$$x = 1500 \ ft$$

Therefore, the concentration in the bedrock aquifer on the downstream end underneath the landfill is (EQ 1 SHEET 6)

$$C_{BO} = C(x = 1500 ft) = \frac{1.2E\text{-}5 \times 1500 \times C_{IN} + 0.13 \times 0.}{0.13 + 1.2E\text{-}5 \times 1500}$$

$C_{BO} = 0.12 \ C_{IN}$ where C_{IN} is the conc. of contaminants within the waste layer

B) Contaminant transport from the edge of the landfill towards the well PW-1, within the bedrock aquifer

A 1-D equation of convective - dispersive transport will be used. The conc. at the edge of the landfill (C_{BO}) will be assumed constant. The flow Q_B will also be assumed constant. The hydraulic conductivity will be assumed as measured in the field in the nearby wells (URS-9 and URS-8) utilizing slug test method and a pressure test method. The porosity of
(SEE RI REPORT)

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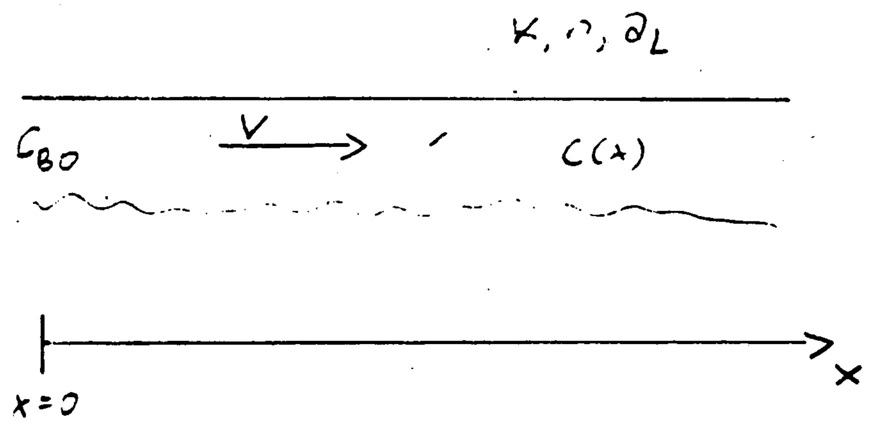
the fractured bedrock will be assumed after "Groundwater and Wells" Second Edition by F.G. Driscoll (SHEET 31). A value of the dispersivity for the site is not known, therefore a range of values will be tried.



C_{BO} - concentration at $x=0$

$$C_{BO} = 0.12\, C_{IN}$$

K - hydraulic conductivity

$$K_{AVG} = \left(\sum_{i=1}^{n} K_i\right) / n \quad \text{(well URS-9)}$$

$$K_{AVG} = \frac{1.6E-3 + 1.6E-3 + 5.7E-6 + 3.2E-5}{4}$$

$$K_{AVG} \approx 8E-4 \text{ CM/S}$$

$$K_{AVG} \cong 2.3 \text{ FT/DAY}$$

i - hydraulic gradient

$$i = \frac{\phi_{URS-8} - \phi_{URS-9}}{L_{URS-8-URS-9}}$$ (as recorded in the field SEE RI REPORT)

$$i = \frac{307 - 302}{200} = 0.025$$

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V – real flow velocity

$$V = Ki/n = \frac{q}{n}$$

$n = 0.05$ (for a fractured, cristalline rock after "Groundwater & Wells" SHEET ?

$$V = \frac{2.3 \times 0.025}{0.05} \left[\frac{\frac{FT}{DAY} \cdot -}{-} = FT/DAY \right]$$

$V = 1.15$ FT/DAY

the governing eq is (for a conservative substance $\lambda = 0$

$$\frac{\partial C}{\partial t} = D_h \frac{\partial^2 C}{\partial x^2} - V \frac{\partial C}{\partial x} \quad \text{(SHEET 36)}$$

where $D_h = a_L V$, $V = \frac{q}{n}$

The solution for the boundary conditions:

$C(x=0) = C_{BO}$
$C(x=\infty) = 0$

and initial conditions

$C(x \geq 0) = 0$

is

$$C(x,t) = \frac{C_{BO}}{2} \left\{ erfc\left[\frac{x - Vt}{2\sqrt{D_h t}}\right] + exp\left(\frac{Vx}{D_h}\right) \cdot erfc\left[\frac{x + Vt}{2\sqrt{D_h t}}\right] \right\}$$

(After "Hydraulics of Groundwater" J. Bear
p 268 formula 7-134 – SEE SHEET

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Assuming that the well PW-1 is located 500 ft from the edge of the landfill.

$$C(500,t) = \frac{0.12 C_{IN}}{2} \left\{ \mathrm{erfc}\left(\frac{500 - 1.15 \cdot t}{2\sqrt{D_h t}}\right) + \exp\left(\frac{1.15 \times 500}{D_h}\right) \cdot \right.$$

$$\left. \cdot\, \mathrm{erfc}\left(\frac{500 + 1.15 \cdot t}{2\sqrt{D_h t}}\right) \right\}$$

where t is in days and $D_h = a_L V$ is in ft²/day.

Values of a_L are usually assumed as being 1 - 100 meters. Following values will be tried a_L = 1, 10, 50, 100 meters (after Freeze & Cherry "Groundwater SHEET 33

a_L [m]	[FT]	$D_h = V \cdot a_L$ [ft²/day]
1	3.3	3.8
10	33	38
50	165	190
100	330	380

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$$erf(x) = \frac{1}{\sqrt{\pi}} \cdot \int_0^x e^{-t^2} dt$$

$$erfc(x) = 1 - erf(x)$$

$$erf(-x) = -erf(x)$$

$$erfc(-x) = 1 + erf(x)$$

$$erf(x) = \frac{1}{\sqrt{\pi}} \cdot \frac{\Delta x}{3} \left(e^{-x_0^2} + 4 \sum_{i=1,3,5,7} e^{-x_i^2} + 2 \sum_{i=2,4,8,10} e^{-x_i^2} + e^{-x_N} \right.$$

where $x_0 = 0$, $x_N = x$, $\Delta x = \frac{x}{N}$, $x_i = i \times \Delta x$

The results for erf function in the range <0; 3> were checked against the tabulated results ("Handbook of Physics and Chemistry")

x	erf(tabulated)	erf (computed)
1.	.842701	.842700781
2.	.995322	.995322251
3.	.999978	.99997789

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4.) Concentration in the bedrock aquifer in the vicinity of PW-1 as a function of time.

a) for $a_L = 1\ m = 3.3\ ft$ $(D_h = 1.15 * 3.3 = 3.8)$

$$C(500,t) = \frac{0.12C_{IN}}{2}\left\{ erfc\left(\frac{500-1.15*t}{2\sqrt{3.8t}}\right) + exp\left(\frac{1.15*500}{3.8}\right) * erfc\left(\frac{500+1.15}{2\sqrt{3.8t}}\right.\right.$$

$$x/a_L = 500/3.8 = 131$$

Since x/a_L is large, assume that the approximation is valid

$$C(500,t) = \frac{0.12C_{IN}}{2} erfc\left(\frac{500-1.15t}{2\sqrt{3.8t}}\right)$$

$$C(500,t) = \frac{0.12C_{IN}}{2} erfc\left(\frac{500-1.15t}{3.83\sqrt{t}}\right)$$

t[DAYS]

t [YEARS]	C [fraction of C_{IN}]
0.5	~0.000
0.7	~0.000
1.0	0.007
1.2	0.066
1.5	0.118
2.0	0.120

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b) for $a_L = 10$ m $\;$ 33 ft $\rightarrow D_h = 1.15 \cdot 33 = 38 \ \frac{ft^2}{day}$

$$c(500,t) = \frac{0.12\, C_{in}}{2} \left\{ erfc\left(\frac{500 - 1.15t}{2\sqrt{38t}}\right) + exp\left(\frac{1.15 \cdot 500}{38}\right) \cdot erfc\left(\frac{500 + 1.15t}{2\sqrt{38t}}\right) \right\}$$

use approximation

$$c(500,t) = \frac{0.12\, C_{in}}{2}\, erfc \frac{500 - 1.15t}{12.3\sqrt{t}}$$

t [YEARS]	c [fraction of C_{in}]
0.5	~0.000
1.0	0.037
1.5	0.091
2.0	0.110
3.0	0.119
3.5	0.120

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c) for $a_L = 50$ m → D = 1.90 ft^2/day

$$c(500,t) = \frac{0.12C_{in}}{2}\left\{ \operatorname{erfc}\frac{500-1.15t}{2\sqrt{130t}} + \exp\left(\frac{1.15 \cdot 500}{190}\right)\operatorname{erfc}\frac{500+1.15t}{2\sqrt{190t}} \right\}$$

since a_L is large, use a full formula

$$C(500,t) = \frac{0.12C_{in}}{2}\left\{ \operatorname{erfc}\frac{500-1.15t}{27.6\sqrt{t}} + 20.5\operatorname{erfc}\frac{500+1.15t}{27.6\sqrt{t}} \right\}$$

t [YEARS]	c [fraction of C_{in}]
0.5	0.026
1.0	0.062
1.5	0.084
2.0	0.101
3.0	0.115
3.5	0.120

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d) for $a_L = 100$ m → $D_L = 330$ ft²/DAY

$$C(500,t) = \frac{0.12C_{in}}{2}\left\{ \operatorname{erfc}\frac{500-1.15t}{39\sqrt{t}} + 1.5\operatorname{erfc}\frac{500+1.15t}{39\sqrt{t}}\right\}$$

t [YEARS]	c [fraction of C_{in}]
0.5	0.030
1.0	0.059
2.0	0.094
2.5	0.095
3.0	0.102
4.0	0.108
6.0	0.114
8.0	0.117
10.0	0.120

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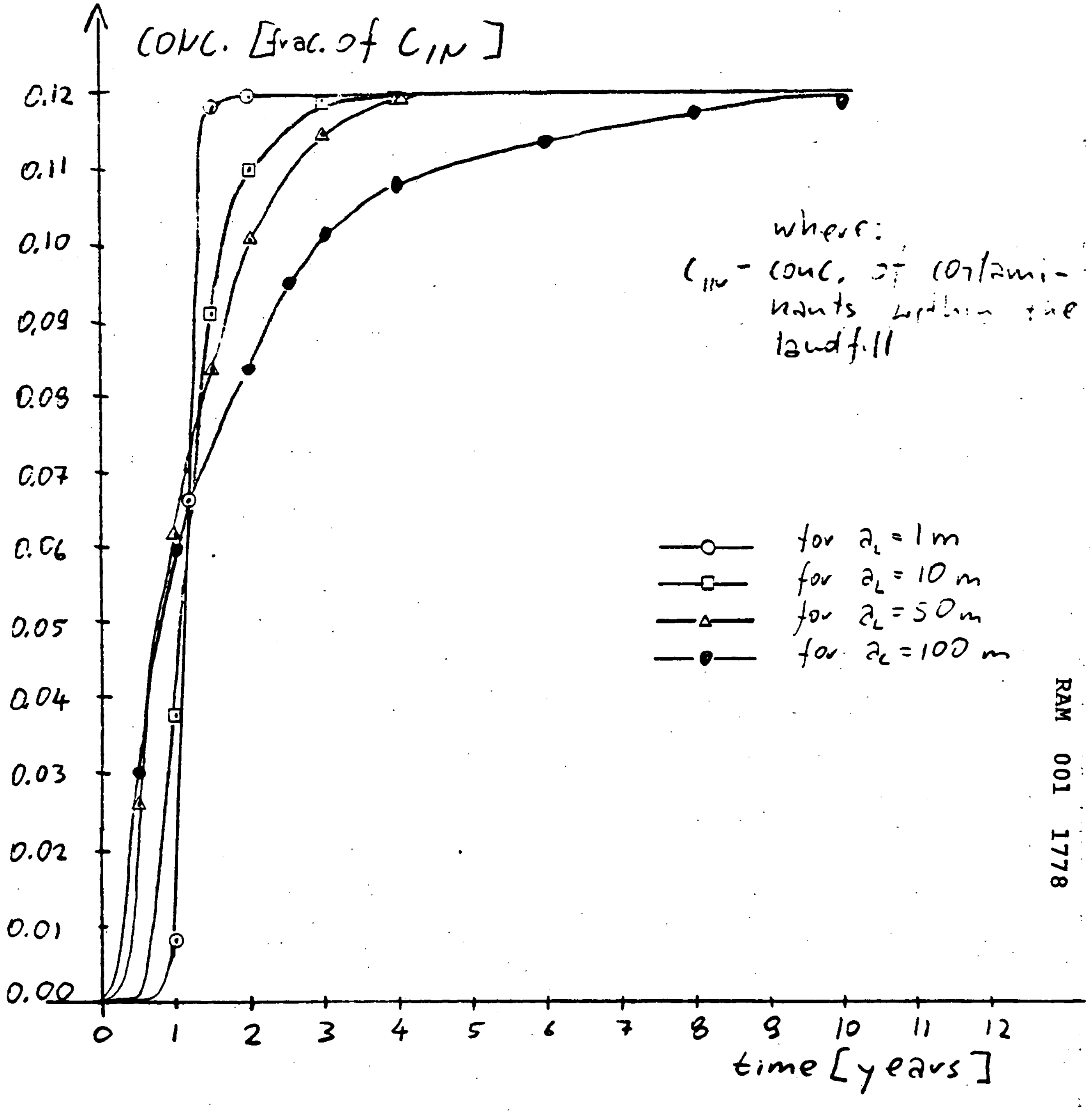
PLOT OF CONCENTRATION VS. TIME IN THE BEDROCK AQUIFER IN THE VICINITY OF RW-1 FOR DIFFERENT VALUES OF THE HYDRODYNAMIC DISPERSIVITY [a_L]

a_L < 1, 100 > meters



where:
C_{IN} - conc. of contaminants within the landfill

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The examination of the contamination of the bedrock aquifer for entire range of a_L values shows that the pollutants are reaching the area immediately below well PW-1 - the steady state concentration of about 12% of C_{in}, where C_{in} is the concentration of contaminants on site.

Therefore, the possibility of contaminants migrating upwards towards the well PW-1 has to be investigated.

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5.) Assessment of the contamination of well PW-1

Well PW-1 is screened in the upper aquifer. The contamination from the landfill is very unlikely to reach PW-1 via the upper aquifer due to the regional flow pattern (see section 2.). However; the bedrock aquifer underneath PW-1 is most probably heavily contaminated (see section 4.) Therefore; the local vertical gradients as resulting from the water withdrawal from PW-1 will be investigated for their influence on the contaminant migration from the bedrock aquifer to the well PW-1. The assessment will be carried out according to the following procedure:

- The withdrawal rate in PW-1 will be estimated.
- Based on the withdrawal rate and the hydrogeology of the aquifers, the drawdowns in the vicinity of PW-1 will be calculated.
- Based on the calculated drawdowns, the vertical gradients in the vicinity of PW-1 will be computed.
- Vertical gradients will be used to calculate the percentage of PW-1 discharge that is drawn from the bedrock aquifer.
- concentration of contaminants in the discharge from PW-1 will be evaluated based on the amount of water drawn from the bedrock aquifer

A boring log for well URS-9, about 250-ft from PW-1, will be assumed as representative of hydrogeologic conditions in the vicinity of PW-1.

a) Withdrawal rate

The withdrawal rate of well RW-1 is not known. Therefore, several discharge rates will be evaluated.

The distribution tank will be assumed as being 1500 gallons. It will also be assumed that the pump is activated if the volume of water in the tank goes down to 500 gallons. That means that the pump must fill 1000 gallons at it's pumping rate. The time to fill up the 1000 gallons volume as a function of discharge is:

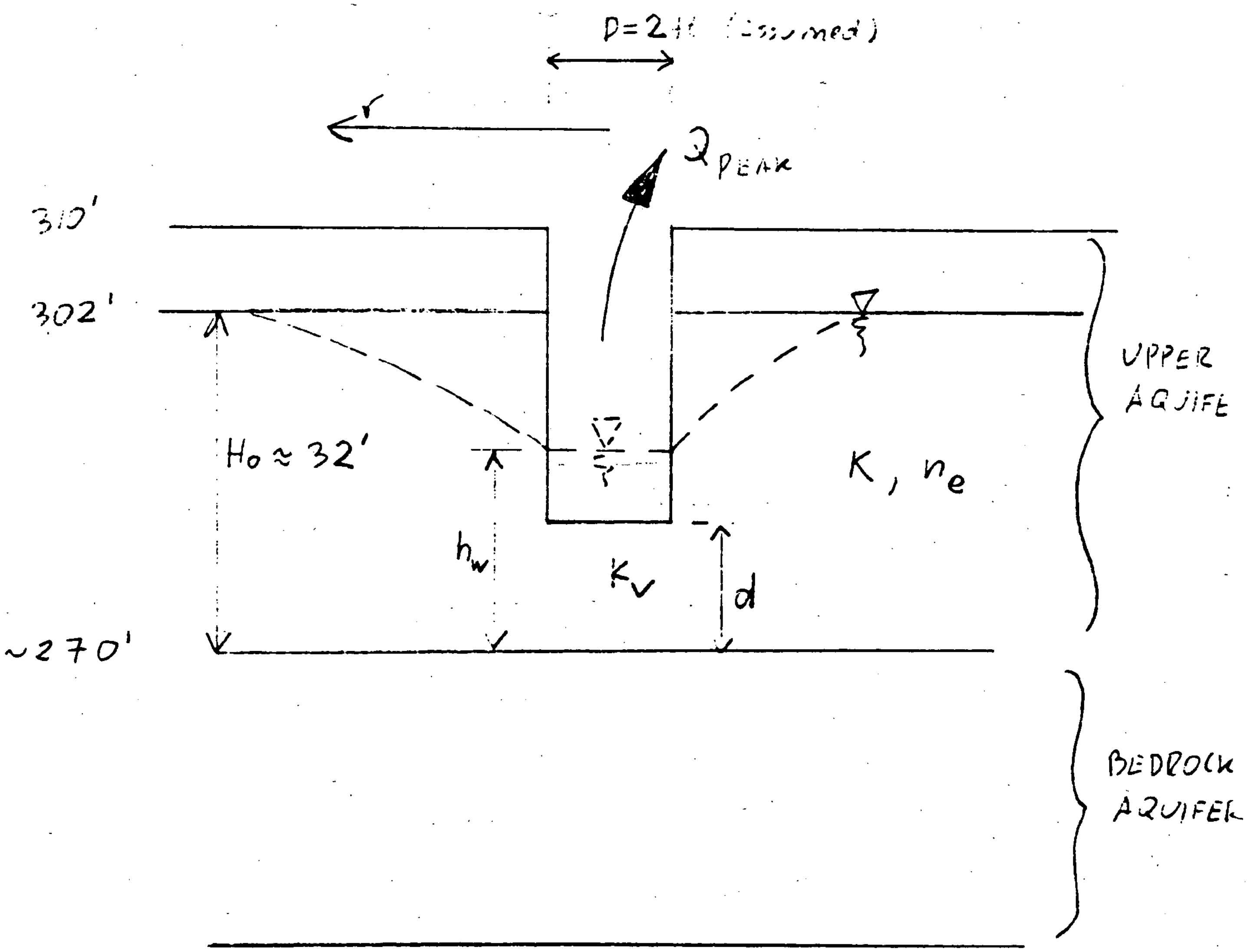
DISCHARGE Q_{PEAK}		TIME OF Q_{PEAK}	
[GPM]	[FT³/D]	[MIN]	[DAYS]
5	960	200	0.140
10	1920	100	0.070
15	2880	67	0.047
20	3840	50	0.035
25	4800	40	0.028

or

$$t = \frac{1000}{Q_{PEAK}} \qquad t\,[MIN] \quad Q_{PEAK}\,[GPM]$$

$$t = \frac{134}{Q_{PEAK}} \qquad t\,[DAYS] \quad Q_{PEAK}\,[FT^3/DAY]$$

b) Dimensions



Based on a boring log URS-9 (250 ft from PW-1
and water level monitored on 8/30/90.

$K = 10$ ft/day (from a calibrated groundwater model, representing average K for both dense and loose sands)

$n_e = 0.3$ (sand) Effective porosity after J. Bear "Hydr of Groundwater" (also called spec yield) SEE SHEET 35

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After J. Bear "Hydraulics of Groundwater", the drawdown in an unconfined aquifer for nonsteady state can be estimated as (see sheets 37, 38)

$$s = \frac{Q_w}{2\pi T}(1+C_f)V(\rho,\tau)$$ away from the well

$$s = \frac{Q_w}{2\pi T}(m - \ln \rho_w)$$ near the pumping well

where

Q_w - well discharge $= Q_{PEAK}$
$T = H_0 * k$ (see figure on sheet 20 for def of H_0, K)
C_f - correction factor
$V(\rho,\tau)$ - gravity well function for phreatic aquifers
$\rho = r/H_0$ (see figure on sheet 20 for def of r, H_0)
$\tau = \frac{Kt}{n_e H_0}$

m = empirical function of τ
t - time

The diameter of the well will be assumed as 2 ft

τ	0.05	0.2	1.0	5.0
m	-.043	.087	.512	1.288

$m(\tau)$

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- drawdowns in the well PW-1 as a function of discharge at peak rate (see formula on sheet 21)

- Q_{peak} (SEE SHEET 19)
- t (SEE SHEET 19)

- $\tau = \frac{Kt}{n_e H_0} = \frac{10 \cdot t}{0.3 \cdot 32} \left[\frac{\frac{FT}{DAY} \cdot DAY}{- \quad FT} = - \right]$ (SHEET 21)

  $\tau = 1.04t$

- $m = f(\tau)$ (SEE SHEET 21)

- $2\pi T = 2\pi K H_o = 2 \cdot 3.14 \cdot 10 \cdot 32 \left[FT/_{DAY} \cdot FT = \frac{FT^2}{DAY} \right]$

  $2\pi K H_o = 2010.\ FT^2/DAY$

- $\rho_w = r_w / H_o = 1.0/_{32} \left[\frac{FT}{FT} = - \right]$ (SEE SHEET

  $\rho_w = 0.03$

Q_{peak}	t	τ	m	$\frac{Q}{2\pi K H_o}$	$m - \ln \rho_w$	S_w	$h_w=30$ $-S_w$
FT^3/D	DAYS	—	—	FT	—	FT	FT
960	.140	.15	.000	.48	3.5	1.7	300.
1920	.070	.07	-.043	.96	3.5	3.4	298.
2880	.047	.05	-.043	1.43	3.5	5.0	297.
3840	.035	.04	-.043	1.91	3.5	6.7	295.
4800	.028	.03	-.043	2.39	3.5	8.4	293.

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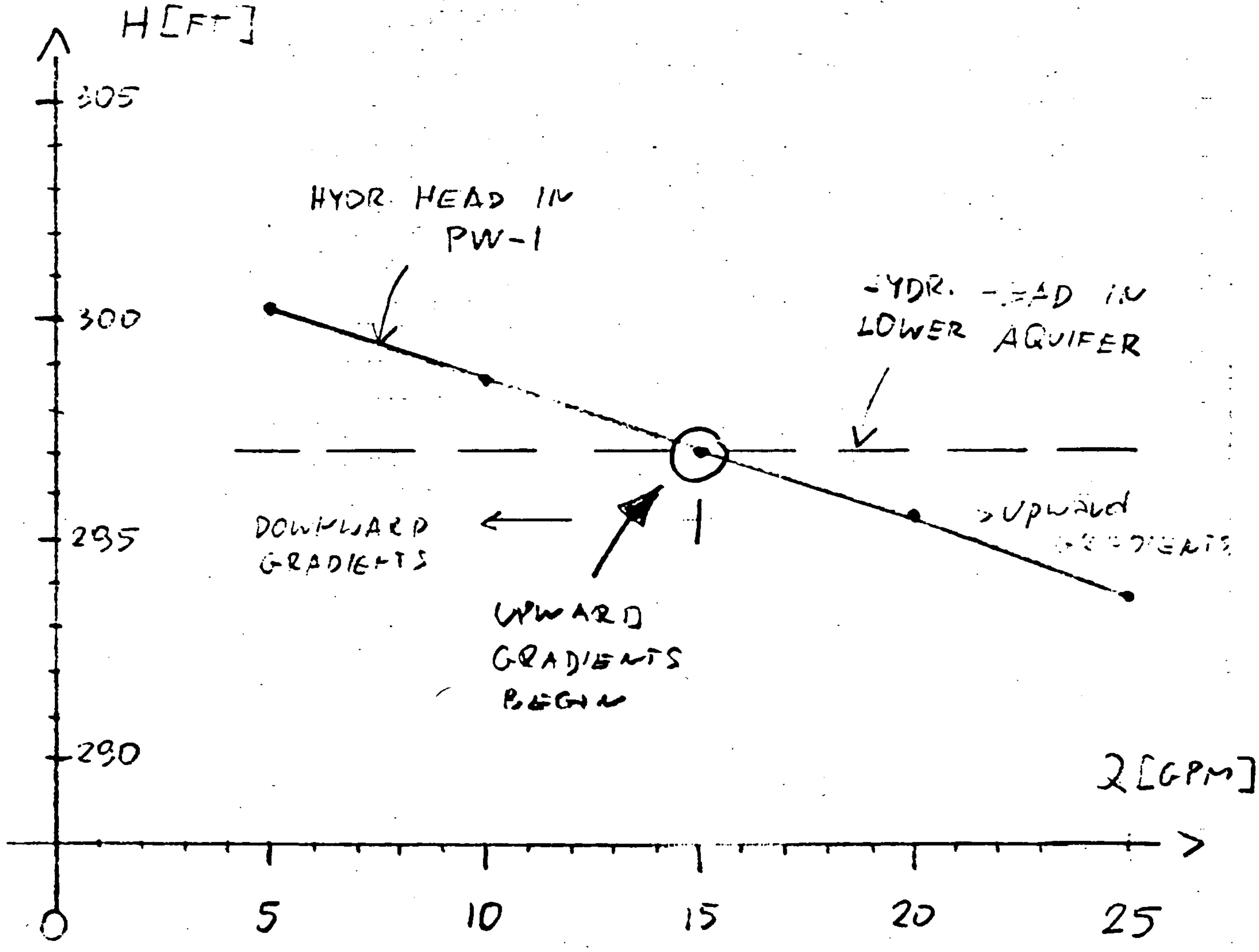
HYDR HEAD IN WELL PW-1 AT THE END OF PUMPING PERIOD FOR DIFFERENT PUMPING RATES



H - Hydr. head

Q - Pumping rate

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c) Based on the results of b) and the monitored level of 297 FT in the bedrock aquifer, the vertical upward gradient exists for $Q_{PEAK} > 15$ gpm. Taking the average i:

$$i = \frac{\Delta h}{d}$$

$$d \approx 10 \text{ ft} \quad , \Delta h = 2 \text{ ft}$$

$$i = 2/10 = 0.2$$

Taking a vertical conductivity at $.1 K_H$,

$$K_V = 01 \times 10 = 1 \text{ FT/DAY}$$

therefore, the flow from the bedrock aquifer to a well for the cone of influence $r = 2r_w$ is:

d) Q_{UPWARD}

$$Q_V = K_V \, i \, A_{ircl}$$

$$Q_u = 1 \times 0.2 \times \frac{\pi 4^2}{4} \quad \left[\frac{FT}{DAY} \times - \times FT^2 = \frac{FT^3}{DAY} \right.$$

$$Q_u = 2.5 \text{ FT}^3\text{/DAY} = 0.01 \text{ GPM}$$

e) Assuming the avg discharge at 20 gpm, the conc. of the contaminants is

$$C_{PW-1} = \frac{Q_{PEAK} \cdot C_{UPPER} + Q_u \cdot C_{BEDROCK}}{Q_{PEAK} + Q_u}$$

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$C_{BEDROCK} = 0.12 C_{IN}$

C_{IN} - CONC. ON SITE

$C_{UPPER} = 0$

$Q_U = 0.01$ GPM

$Q_{PERM} = 20$ GPM

$$C_{PW-1} = \frac{20 \times 0 + 0.01 \times 0.12 C_{IN}}{20 + 0.01}$$

$C_{PW-1} = 6E\text{-}5 \; C_{IN}$

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6) SUMMARY

BASED ON THE PRECEEDING CALCULATIONS, THE FOLLOWING CONCLUSIONS CAN BE MADE:

- THE CONTAMINATED GROUNDWATER WITHIN THE UPPER SANDY AQUIFER IS INTERCEPTED BY THE TORNE BROOK. THEREFORE; THE RESIDENTIAL WELL PW-1 WHICH IS LOCATED ON THE OPPOSITE SIDE OF THE BROOK IS NOT BEING CONTAMINATED VIA THE UPPER AQUIFER.

- DOWNWARD GRADIENTS PREVAIL ACCROSS THE SITE AND THE CONTAMINATED GROUNDWATER FROM THE LANDFILL IS INFILTRATING INTO THE LOWER (BEDROCK) AQUIFER. THEREFORE; THE BEDROCK AQUIFER UNDERNEATH THE LANDFILL IS HEAVILY CONTAMINATED. AS THERE IS NO BARRIER RESTRICTING THE GROUNDWATER MOVEMENT WITHIN THE BEDROCK AQUIFER, THE CONTAMINATION SPREADS TOWARDS THE RESIDENTIAL WELL PW-1 AND RAMAPO RIVER. IT IS ESTIMATED THAT AT THE PRESENT TIME THE GROUNDWATER WITHIN THE BEDROCK AQUIFER RIGHT UNDERNEATH THE WELL PW-1 CARRIES A CONCENTRATION OF CONTAMINANTS OF ABOUT 12% OF THAT DIRECTLY IN THE LANDFILL.

- ESTIMATED WITHDRAWAL RATES IN WELL PW-1 ARE TO SMALL TO CAUSE SIGNIFFICANT UPWARD FLOWS FROM THE BEDROCK AQUIFER. IT WAS ESTIMATED THAT, DEPENDING ON THE WITHDRAWAL RATES ASSUMED, THE CONCENTRATION OF CONTAMINANTS IN THE WELL WATER CAN VARY FROM ZERO TO $10^{-5} C_{in}$, WHERE C_{in} IS THE CONC. OF CONTAMINANTS WITHIN THE WASTE AREA. THEREFORE; IT IS QUESTIONABLE WHEATHER THE WELL PW-1 IS ACTUALLY EXPERIENCING EFFECTS OF THE CONTAMINATION OF THE BEDROCK AQUIFER.

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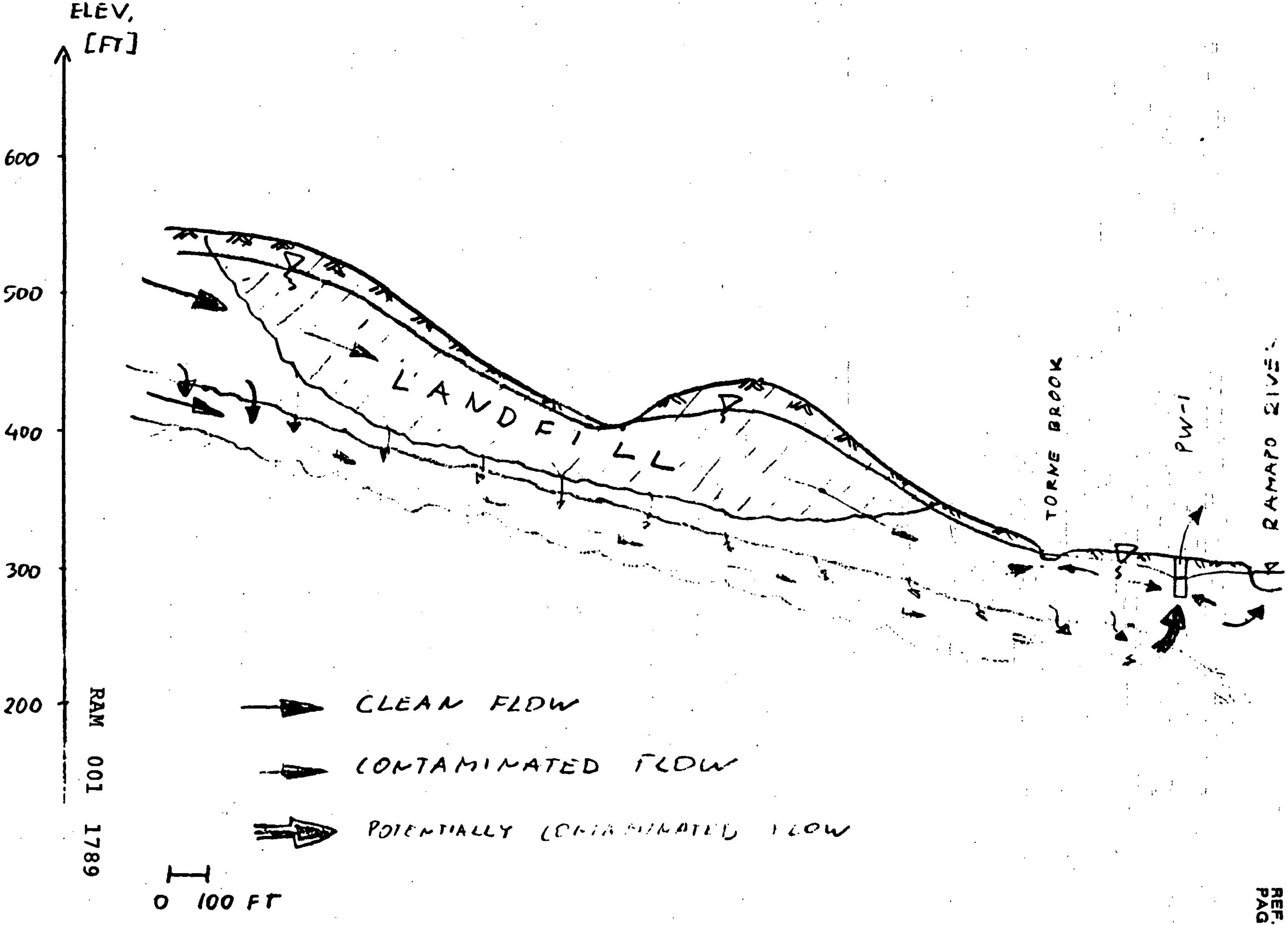
CONTAMINANT MIGRATION PATTERN



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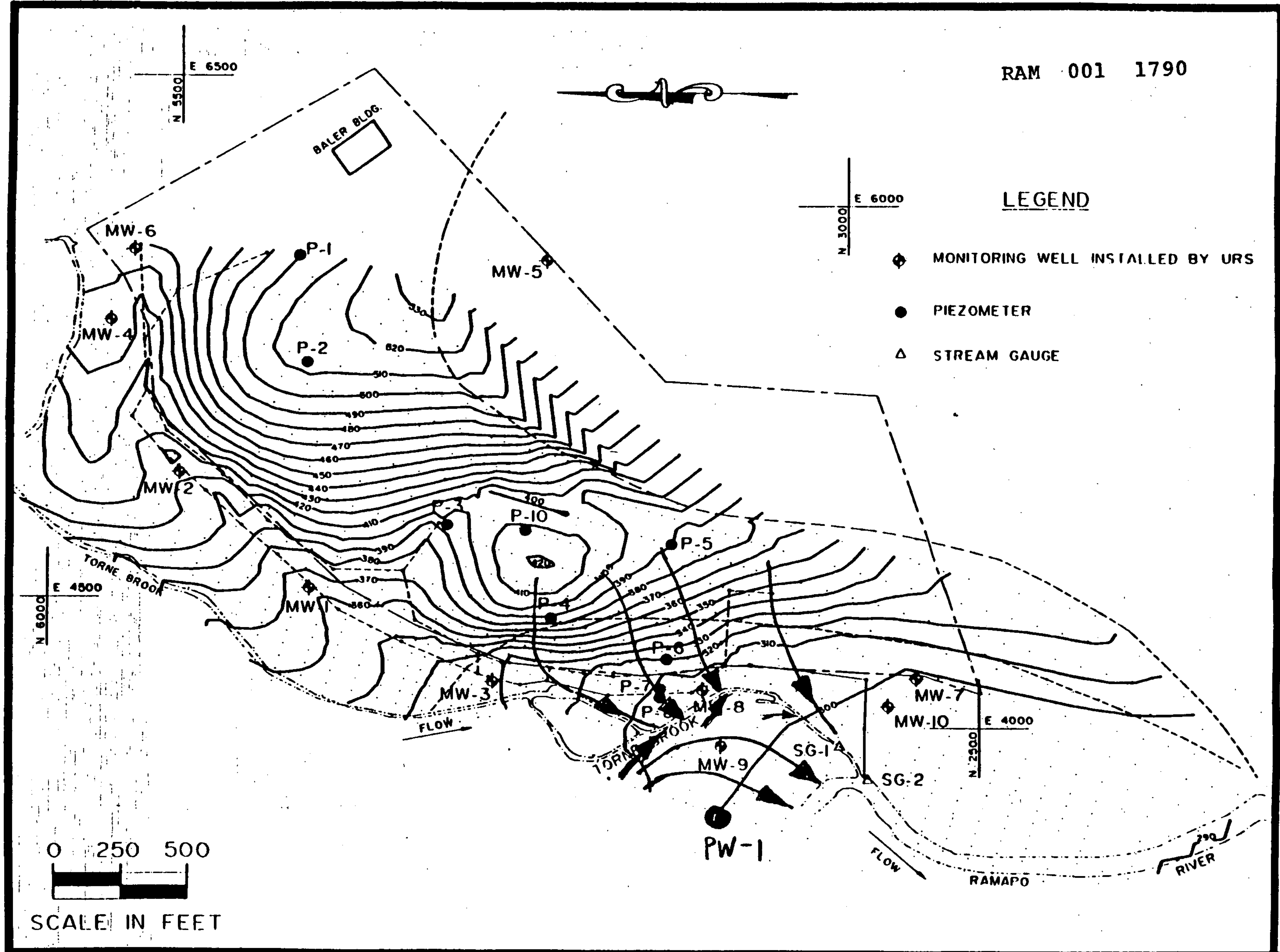

LEGEND

- ⊕ MONITORING WELL INSTALLED BY URS
- ● PIEZOMETER
- △ STREAM GAUGE

FIGURE

HYDRAULIC HEADS IN LAYER ONE

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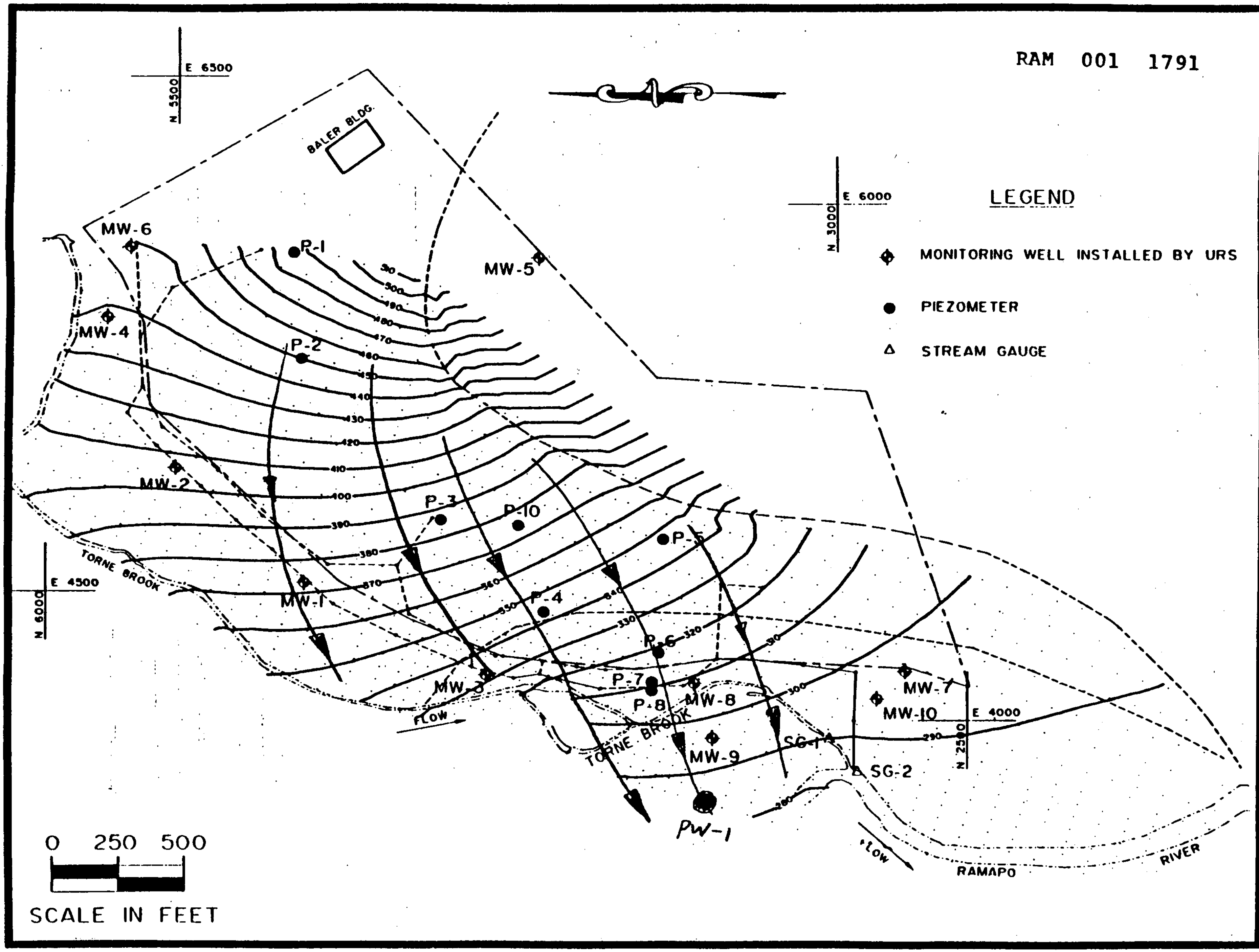

FIGURE

HYDRAULIC HEADS IN LAYER TWO

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Groundwater
and
Wells

Second Edition

Fletcher G. Driscoll, Ph.D.
Principal Author and Editor

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Table 5.1 Porosities for Common Consolidated and Unconsolidated Materials

Unconsolidated Sediments	η (%)	Consolidated Rocks	η (%)
Clay	45–55	Sandstone	5–30
Silt	35–50	Limestone/dolomite (original & secondary porosity	1–20
Sand	25–40		
Gravel	25–40	Shale	0–10
Sand & gravel mixes	10–35	Fractured crystalline rock	0–10
Glacial till	10–25	Vesicular basalt	10–50
		Dense, solid rock	< 1

volume of water an aquifer can hold, it does not indicate how much water the aquifer will yield.

When water is drained from a saturated material under the force of gravity, the material releases only part of the total volume stored in its pores. The quantity of water that a unit volume of unconfined aquifer gives up by gravity is called its specific yield (Figure 5.5). Specific yields for certain rocks and sediment types are presented in Table 5.2. Some water is retained in the pores by molecular attraction and capillarity. The amount of water that a unit volume of aquifer retains after gravity drainage is called its specific retention. The smaller the average grain size, the greater is the percent of retention; the coarser the sediment, the greater will be the specific yield when compared to the porosity. The surface area for different-size sand grains is shown in Table 5.3. Note the large increase in surface area for the finest sediment. As the surface area increases, a larger percentage of the water in the pores is held by surface tension or other adhesive forces. Therefore, finer sediments have lower specific yields compared to coarser sediments, even if they both have the same porosity.

Specific yield plus specific retention equals the porosity of an aquifer. Both specific yield and specific retention are expressed as decimal fractions or percentages. Specific yields of unconfined aquifers (equivalent to their storage coefficients*) range from 0.01 to 0.30. Specific yields cannot be determined for confined aquifers because the aquifer materials are not dewatered during pumping.

Storage coefficients are much lower in confined aquifers because they are not drained during pumping, and any water released from storage is obtained primarily by compression of the aquifer and expansion of the water when pumped. During

Table 5.2. Representative Specific Yield Ranges for Selected Earth Materials

Sediment	Specific Yield, %
Clay	1–10
Sand	10–30
Gravel	15–30
Sand and Gravel	15–25
Sandstone	5–15
Shale	0.5– 5
Limestone	0.5– 5

(Walton, 1970)

---

*The coefficient of storage is fully defined in Chapter 9. Briefly, it is the volume of water taken into or released from storage per unit change in head per unit area.

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Hydraulics of Groundwater

SHEET

Case 5. Movement of a radioactive tracer in a semi-infinite column This is the case where the column ($x > 0$), initially at tracer concentration $C = 0$, is connected to a reservoir containing a tracer solution of constant concentration C_0. The flow in the column is maintained at a constant specific discharge q in the $+x$ direction. The tracer continuously undergoes radioactive decay.

The partial differential equation here is

$$\frac{\partial C}{\partial t} = D_h \frac{\partial^2 C}{\partial x^2} - \frac{q}{n}\frac{\partial C}{\partial x} - \lambda C \tag{7-130}$$

where $\lambda = \ln 2/T$ and T is the half-life of the radioactive tracer.

We *assume* that at $x = 0$ the concentration immediately reaches its ultimate level C_0 upon commencement of flow. This is equivalent to an assumption that at $x = 0$, $\lim_{t \to 0} \partial C/\partial x = 0$. We refer to this condition as an assumption since from (7-71) it follows that at $x = 0$ the boundary condition should actually be

$$C_0 q = Cq - nD_h\, \partial C/\partial x$$

or $$\tag{7-131}$$

$$q(C_0 - C) = -nD_h\, \partial C/\partial x$$

Accordingly, the initial and boundary conditions are

$$\begin{aligned} &t \le 0, && x \ge 0, && C = 0 \\ &t > 0, && x = 0, && C = C_0 \\ & && x = \infty, && C = 0 \end{aligned} \tag{7-132}$$

By applying the Laplace transform to (7-130) and (7-132), we obtain the solution (Bear, 1972, p. 630)

$$\begin{aligned} C(x,t) = \frac{C_0}{2}\exp\left\{\frac{qx}{2nD_h}\right\}\cdot\Bigg[&\exp(-x\beta)\cdot \operatorname{erfc}\frac{x - [(q/n)^2 + 4\lambda D_h]^{1/2}\, t}{2[D_h t]^{1/2}} \\ &+ \exp(\beta x)\cdot \operatorname{erfc}\frac{x + [(q/n)^2 + 4\lambda D_h]^{1/2}\, t}{2[D_h t]^{1/2}}\Bigg] \end{aligned} \tag{7-133}$$

where $\beta^2 = q^2/4n^2 D_h^2 + \lambda/D_h$.

For $\lambda = 0$ (i.e., without radioactive decay), (7-133) reduces to

$$C(x,t) = \frac{C_0}{2}\left\{\operatorname{erfc}\frac{x - (q/n)\,t}{2[D_h t]^{1/2}} + \exp\left(\frac{qx}{nD_h}\right)\cdot \operatorname{erfc}\frac{x + (q/n)\,t}{2[D_h t]^{1/2}}\right\} \tag{7-134}$$

If we now introduce adsorption (see Case 2), (7-134) becomes

$$C(x,t) = \frac{C_0}{2}\left\{\operatorname{erfc}\frac{R_d x - (q/n)\,t}{2[R_d D_h t]^{1/2}} + \exp\left(\frac{qx}{nD_h}\right)\operatorname{erfc}\frac{R_d x + (q/n)\,t}{2[R_d D_h t]^{1/2}}\right\}. \tag{7-135}$$

Curves describing (7-134) are shown in Fig. 7-12. According to Ogata and Banks (1961), who also obtained (7-134), the second term in (7-134) may be neglected from the volume of pore space between the two positions of the phreatic surface. The storativity of a phreatic aquifer is, therefore, sometimes referred to as *specific yield*, S_y; it gives the yield of an aquifer per unit area and unit drop of the water table (see further discussion in Sec. 6-1).

Recalling that actually the water table is an approximate concept, we understand that water is actually being drained from the entire column of soil up to the ground surface. Bear (1972, p. 485) shows that when the soil is homogeneous and the fluctuating water table is sufficiently deep, the above definition for specific yield still holds (see Sec. 6-1).

One should be careful not to identify the specific yield with the porosity of a phreatic aquifer. As water is being drained from the interstices of the soil, the drainage is never a complete one. A certain amount of water is retained in the soil against gravity by capillary forces. After drainage has stopped, the volume of water retained in an aquifer per unit (horizontal) area and unit drop of the water table is called *specific retention*, S_r. Thus

$$S_y + S_r = n \tag{5-12}$$

For this reason S_y ($<n$) is sometimes called *effective porosity*. Here, again, one should note that we have been referring to the approximate concept of a water table. However, for a homogeneous soil and a sufficiently deep water table, the above definition for S_r holds (see Sec. 6-1).

Figure 5-4 shows the relationships between S_y, S_r, and particle size.

When drainage occurs, it takes time for the water to flow, partly under unsaturated flow conditions, out of the soil volume between two positions of a water table, at t and at $t + \Delta t$. This is especially true if the lowering of the water table is rapid. Under such conditions, the specific yield becomes time dependent, gradually approaching its ultimate value (Fig. 5-5). When the water level is rising or falling slowly, the changes in moisture distribution have time to adjust continuously and the time lag vanishes. This phenomenon of time dependency of the

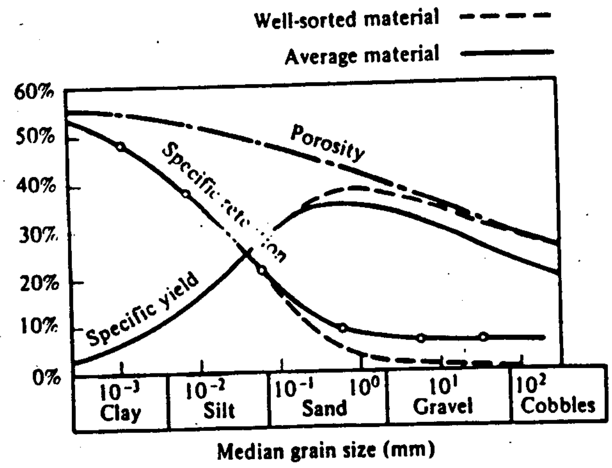

Figure 5-4 Relationship between specific yield and grain size (*from Conkling et. al., 1934, as modified by Davis and DeWiest, 1966*).

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tracer front to advance in a pattern commonly referred to as *fingering*. In this case the contaminant is transported more rapidly in the lenses or beds of higher hydraulic conductivity. Figure 9.9(c) illustrates results obtained by Skibitzke and Robertson (1963) using dye tracers in a box model packed with fine sand and long sinuous lenses of coarser sand. These authors observed that a large angle of refraction at the boundary between sand of contrasting permeability caused accelerated spreading of the tracer zone.

In one of the very few detailed three-dimensional studies of contaminant movement in sandy deposits, Childs et al. (1974) observed that "plumes migrate along zones . . . that, although they are texturally similar, show subtle differences in fabric that result in slight variations in permeability. Bifurcations indicate that detection of a shallow plume does not negate the existence of the other plumes of the same constituent at depth" (p. 369).

Nearly all studies of dispersion reported in the literature have involved relatively homogeneous sandy materials under controlled conditions in the laboratory. These studies have indicated that the dispersivity of these materials is small. Values of longitudinal dispersivity are typically in the range of 0.1 to 10 m with transverse dispersivity values normally lower by a factor of 5–20. Whether or not these values are at all indicative of dispersivities in field systems is subject to considerable controversy at the present time. Many investigators have concluded that values of longitudinal and transverse dispersivities in field systems are significantly larger than values obtained in laboratory experiments on homogeneous materials or on materials with simple heterogeneities. Values of longitudinal dispersivity as large as 100 m and lateral dispersivity values as large as 50 m have been used in mathematical simulation studies of the migration of large contaminant plumes in sandy aquifers (Pinder, 1973; Konikow and Bredehoeft, 1974; Robertson, 1974).

To illustrate the effect of large dispersivities on the migration of contaminants in a hypothetical groundwater flow system, a cross-sectional flow domain similar to that shown in Figure 9.8(a) and (b) will be used. Figure 9.10 shows the effect of dispersivity on the spreading of a contaminant plume that emanates from a source in the recharge area of the flow system. Although the cross sections shown in Figure 9.10 are homogeneous, dispersivities for the system are assumed to be large as a result of small-scale heterogeneities. With assigned values of dispersivity the patterns of contaminant distribution can be simulated using a finite-element approximation to the transport equation expressed in two-dimensional form for saturated heterogeneous isotropic media [Eq. (A10.13), Appendix X]:

$$\frac{\partial}{\partial s_l}\left(D_l \frac{\partial C}{\partial s_l}\right) + \frac{\partial}{\partial s_t}\left(D_t \frac{\partial C}{\partial s_t}\right) - \frac{\partial}{\partial s_l}(\bar{v}_l C) = \frac{\partial C}{\partial t} \tag{9.8}$$

where s_l and s_t are the directions of the groundwater flowlines and the normals to these lines, respectively. The finite-element model used to obtain the contaminant distributions shown in Figure 9.10 is described by Pickens and Lennox (1976).

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that is, an infinitesimally narrow well with a discharge, Q_w, entering uniformly along the original depth of saturation, H_0, although the actual length of saturation at the face of the well varies during pumpage. Finally, he assumes that the contribution to the flow by water and aquifer compression may be neglected, except during the very early period of pumping, i.e., the right-hand side of (8-85) may be assumed zero. One should notice that he nevertheless solves for $\phi = \phi(r, z, t)$, because of the nonsteady boundary condition (8-91). Under these conditions Boulton's solution is

$$H_0 - \phi(r, z, t) = \frac{Q_w}{2\pi T} \int_0^\infty \frac{J_0(\chi r/H_0)}{\chi} \left\{ 1 - \frac{\cosh \chi z/H_0}{\cosh \chi} \exp[-\tau\chi \tanh \chi] \right\} d\chi \tag{8-91b}$$

and

$$s(r, t) = H_0 - h(r, t) = \frac{Q_w}{2\pi T} V(\rho, \tau)$$

$$\equiv \frac{Q_w}{2\pi T} \int_0^\infty \frac{J_0(\chi\rho)}{\chi} \{1 - \exp(-\tau\chi \tanh \chi)\} d\chi \tag{8-91c}$$

where $\rho = r/H_0$, $\tau = Kt/n_e H_0$, $T = KH_0$. To minimize the errors involved in obtaining (8-91c), a correction factor C_f is applied to the latter

$$\underline{s = \frac{Q_w}{2\pi T}(1 + C_f) V(\rho, \tau)} \tag{8-91d}$$

where C_f depends on ρ, τ, r_w/H_0 and Q_w/H_0^2. Boulton (1954), Schoeller (1959) and Hantush (1964) give values of V and C_f (in the form of graphs and tables) which range from about -0.30 to about 0.16. The values of C_f are given separately for $\tau > 5$ and for $\tau < 0.05$. In the range $0.05 < \tau < 5$, C_f may be assumed zero with an error not exceeding six percent.

The values of the *gravity well function for phreatic aquifers* $V(\rho, \tau)$ may also be approximated as follows

For $\tau < 0.05$

$$V(\rho, \tau) \approx \sinh^{-1}(1/\rho) + \sinh^{-1}(\tau/\rho) - \sinh^{-1}[(1 + \tau)/\rho]$$

For $\tau > 5$

$$V(\rho, \tau) \approx \tfrac{1}{2} W(\rho^2/4\tau) = \tfrac{1}{2} W(u); \qquad u = n_e r^2/4Tt$$

where $W(u)$ is the *well function of a confined aquifer.*

For $\tau < 0.01$

$$V(\rho, \tau) \approx \sinh^{-1}(\tau/\rho) - \tau/\sqrt{1 + \rho^2}$$

For $\tau < 0.01$ and $\tau/\rho > 10$

$$V(\rho, \tau) \approx \ln(2\tau/\rho)$$

SHEET 3

For the drawdown in the pumped well, Boulton (1954) suggests for $\tau < 0.05$, to compute the drawdown by (8-91d), with $\rho \to \rho_w = r_w/H_0$ and $h \to h_w$; for $0.05 < \tau < 5$, the drawdown may be computed from

$$s_w = H_0 - h_w = \frac{Q_w}{2\pi T}(m - \ln \rho_w) \tag{8-92}$$

where

τ	0.05	0.2	1.00	5.00
m	−0.043	0.087	0.512	1.288

and intermediate values may be obtained by interpolation.

For $\tau > 5$, we have

$$H_0^2 - h_w^2 = \frac{Q_w}{\pi K} \ln\left(\frac{1.5\sqrt{\tau}}{\rho_w}\right) = \frac{Q_w}{2\pi K} \ln \frac{2.25Tt}{n_e r_w^2} \tag{8-93}$$

to be compared with (8-24) and (8-92).

The drawdown for an anisotropic aquifer may be obtained by replacing τ by $\tau' = K_z t/n_e H_0$ and ρ by $\rho' = (r/H_0)(K_z/K_r)^{1/2}$.

Hantush (1964) discusses the drawdown in observation wells at some distance from a pumping well. In the region $r > 1.5H$, equipotentials are practically vertical and the average drawdown in observation wells is practically equal to the drawdown of the water table given by (8-91d).

In the region $r < 1.5H_0$, Hantush (1964) suggests for $(H_0 - h_w) < 0.5H_0$ and $t > 30\, r^2 n_e/T$

$$H_0^2 - \bar{h}^2 = (Q_w/2\pi K)\, W(u): \qquad u = n_e r^2/4Tt: \qquad T \approx KH_0 \tag{8-94}$$

where $\bar{h}$ is the average head defined by $\bar{h} = (1/h)\int_0^h \phi(r, t)\, dz\ (\bar{h} < h)$. For $u < 0.05$, or $t > 5\, r^2 n_e/T$

$$H_0^2 - \bar{h}^2 = (Q/2\pi K) \ln \frac{2.25\, Tt}{n_e r^2} \tag{8-95}$$

Closer to a pumping well, (8-94) gives approximately the depth $\bar{h}$ of water in a piezometer open at the impervious horizontal base of an aquifer (smaller than the actual water level in an observation well located above that point).

One should note, that in (8-94) and (8-95)

$$H_0^2 - \bar{h}^2 = (H_0 - \bar{h})(H_0 + \bar{h}) = s(H_0 + H_0 - s) = 2H_0 s(1 - s/2H_0)$$

which for $s \ll 0.02H_0$ may be approximated by $2H_0 s$ so that the Theis formula (8-61) and Jacob's straight line approximation (8-62) are applicable.

Boulton (1965) solves also the case of a well pumping from an aquifer of infinite areal extent with a constant drawdown at the pumping well. Here also the exact non-linear phreatic surface boundary condition is replaced by the approximate one (8-87), so that the boundary and initial conditions may be summarized by (Fig. 8-6)

APPENDIX P.4

GAS EMISSIONS

URS CONSULTANTS, INC.

PAGE 0 OF 20
SHEET NO. OF
JOB NO.
MADE BY MO DATE 08/01/
CHKD. BY NC DATE 8/1/9

PROJECT RAMAPO LANDFILL
SUBJECT GAS EMISSIONS

REF.
PAGE

1.) GENERAL

The purpose of this calculation is to estimate concentrations of contaminants in air due to emissions from the Ramapo Landfill.

2.) METHODOLOGY

The calculations were performed following the methodology outlined in the " New York State Air Guide – 1 ", draft of the 1991 edition. The process consisted of the following steps :

A. Estimation of emission rates
B. Determination of points of concern
C. Calculation of contaminant concentrations in air at the points of concern

3.) CALCULATIONS

A.) Estimation of emission rates

According to the requirements of the " NYS Air Guide – 1 " area source method, the landfill was divided into sections that could be represented by square areas. Two sections were selected :

Area 1 – North lobe
Area 2 – South lobe (see Ref.1, page 7)

According to the USEPA estimates, a cubic yard of refuse generates 220 cubic feet of gas per year (see Ref.2,page 11). Based on that, if the produced gas contains concentration "C" of a particular compound, the emission rate of that compound is :

$$Qa = 220*V*C \qquad (1)$$

Where :

Qa – annual emission rate [lb/yr]
220 – yearly production of gas from 1 cy of refuse [ft^3/cy*yr]
V – volume of refuse [cy]
C – concentration of compound in emitted gas [lb/ft^3]

B.) Determination of points of concern

The " Air Guide – 1 " methods estimate the concentrations of contaminants in air directly downwind from the source. The site was analyzed in order to determine points of potentially highest impact, located at the property boundry. The following criteria were taken into account :

- Proximity to source
- Compounding effect of emissions from both area1 and area 2

Based on that, the following points on the property line were found to have potentially high contaminant concentrations :

Point 1 – Northeast of the north lobe, due to the proximity to Area 1 and compounding effects of emissions from both Area 1 and Area 2
Point 2 – Northwest of the north lobe, due to the location at the boundry of Area 1 .
Point 3 – West of the south lobe, due to the location at the boundry of Area 2
Point 4 – Southwest of south lobe, due to the location at the boundry of Area 2 and compounding effects of emissions from both Area 1 and Area 2

For locations of points 1, 2, 3 and 4 see page 7.

C.) Calculation of contaminant concentrations in air at the points of concern

The area source method of the " NYS Air Guide – 1 " was utilized. For the description of the method see Ref.3, pages 13–18.

Explanation of terms :

D – Distance from the center of the source area to the point of concern [ft]
A – Surface area of source [ft^2]
S – Side length of the area source [ft]
S = SQRT(A) (2)
Re – Effective radius of the area source [ft]
Re = 0.56*S (3)
Ha – Height of the area source [ft]
V – Volume of refuse [cy]
C – Concentration of contaminant in emitted gas [lb/ft^3]
Qa – Source emission rate [lb/yr]
Qa = 220*V*C (1)
QA – Source emission rate [lb/hr*ft^2]
QA = Qa/8760*A (4)
K – Coefficient
K = 15 for 330 ft < S < 3300 ft
K = 30 for S > 3300 ft (5)
Cm – Conversion factor from lb/hr*ft^2 to µg/m^2*sec
C = 1.355e+6
Ca – Maximum Annual Actual Impact conc. [µg/m^3]

For the receptor located outside of the source area (D > Re) :

Ca = 104*Qa/[(D+S)^1.6*Ha^0.368] (6)

For the receptor located inside the source area (D < Re) :

Ca = K * QA * Cm (7)

Site – specific values :

	SURFACE AREA	WASTE VOLUME	SIDE LENGTH	EFFECTIVE RADIUS	SOURCE HEIGHT		EMISSION RATE	EMISSION RATE
	A	V	S	Re	Ha	K	Qa	QA
	[acres]	[cy]	[ft]	[ft]	[ft]		[lb/yr]	[lb/hr*ft^2]
Source	Ref.4 Pg.20	Ref.4 Pg.20	(2)	(3)	Ref.3 Pg.15	(5)	(1)	(4)
AREA 1	32.00	1,350,000	1,181	661	3	15	2.97E+08 *C1	2.43E-02 *C1
AREA 2	16.00	618,000	835	468	3	15	1.36E+08 *C2	2.23E-02 *C2

MAXIMUM ANNUAL ACTUAL IMPACT CONCENTRATIONS AT POINTS OF CONCERN

POINT 1

Source contrib.	D [ft]	Re [ft]	Point location /Method used	Ca [μg/m^3]
AREA 1	1000	661	D>Re, use (6)	9.39E+04 * C1
AREA 2	2100	468	D>Re, use (6)	2.67E+04 * C2

Ca tot = 9.39E+04 * C1 + 2.67E+04 * C2 [μg/m^3]

POINT 2

Source contrib.	D [ft]	Re [ft]	Point location /Method used	Ca [μg/m^3]
AREA 1	600	661	D<Re, use (7)	4.94E+05 * C1

POINT 3

Source contrib.	D [ft]	Re [ft]	Point location /Method used	Ca [μg/m^3]
AREA 2	450	661	D<Re, use (7)	4.53E+05 * C2

POINT 4

Source contrib.	D [ft]	Re [ft]	Point location /Method used	Ca [μg/m^3]
AREA 1	1700	661	D>Re, use (6)	6.01E+04 * C1
AREA 2	600	468	D>Re, use (6)	8.39E+04 * C2

Ca tot = 6.01E+04 * C1 + 8.39E+04 * C2 [μg/m^3]

Based on the monitoring results of RI, the MAXIMUM concentrations of contaminants in gas emitted from the landfill are : (see Ref. 1, pages 7,8,9,10)

Parameter	Avg. Conc. for Area 1 (C1) PSR-2,3,3D,4,4BT		Avg. Conc. for Area 2 (C2) VOC-1,2,3		Maximum Conc.
	[mg/m^3]	[lb/ft^3]	[mg/m^3]	[lb/ft^3]	[lb/ft^3]
2-Butanone	0.0180	1.12E-09	0.0079	4.93E-10	1.12E-09
1,1,1-Trichloroethane	0.0011	6.86E-11	0.0008	4.99E-11	6.86E-11
Carbon Tetrachloride	0.0004	2.50E-11	0.0002	1.25E-11	2.50E-11
Benzene	0.0290	1.81E-09	0.0007	4.37E-11	1.81E-09
Chlorobenzene	0.3700	2.31E-08	0.0005	3.12E-11	2.31E-08
Ethylbenzene	1.2000	7.49E-08	0.0026	1.62E-10	7.49E-08
Tetrachloroethylene	0.0041	2.56E-10	0.0000	0.00E+00	2.56E-10
Styrene	0.0008	4.99E-11	0.0005	3.12E-11	4.99E-11
Toluene	0.2700	1.68E-08	0.0079	4.93E-10	1.68E-08
Xylene (Total)	7.7000	4.80E-07	0.0110	6.86E-10	4.80E-07
Methylene Chloride	0.0030	1.87E-10	0.0018	1.12E-10	1.87E-10
Acetone	0.0180	1.12E-09	0.0160	9.98E-10	1.12E-09

The concentrations at points of concern were calculated based on the assumption that, for each compound, the representative concentration in the emitted landfill gas is equal to maximum concentration of that compound detected in all sampling points, i.e. C1=C2=MAX[C1,C2] (see above table).
From that, and based on the results from page 3, the concentrations at the points of concern are :

Parameter	Concentrations [μg/m^3]			
	POINT 1	POINT 2	POINT 3	POINT 4
2-Butanone	1.35E-04	5.55E-04	5.08E-04	1.62E-04
1,1,1-Trichloroethane	8.28E-06	3.39E-05	3.11E-05	9.89E-06
Carbon Tetrachloride	3.01E-06	1.23E-05	1.13E-05	3.60E-06
Benzene	2.18E-04	8.95E-04	8.19E-04	2.61E-04
Chlorobenzene	2.78E-03	1.14E-02	1.04E-02	3.33E-03
Ethylbenzene	9.03E-03	3.70E-02	3.39E-02	1.08E-02
Tetrachloroethylene	3.08E-05	1.26E-04	1.16E-04	3.69E-05
Styrene	6.02E-06	2.47E-05	2.26E-05	7.19E-06
Toluene	2.03E-03	8.33E-03	7.63E-03	2.43E-03
Xylene (Total)	5.79E-02	2.38E-01	2.17E-01	6.92E-02
Methylene Chloride	2.26E-05	9.25E-05	8.47E-05	2.70E-05
Acetone	1.35E-04	5.55E-04	5.08E-04	1.62E-04

The highest concentrations of each of the parameters, as compared to TLV and AGC standards, are :

Parameter	Highest conc. (Ca)	Location	TLV/300 conc.	AGC	Ca > TLV or Ca > AGC
	[μg/m^3]	Point #	[μg/m^3]	[μg/m^3]	
2-Butanone	5.55E-04	2	1.97E+03	3.00E+02	No
1,1,1-Trichloroethane	3.39E-05	2	6.37E+03	1.00E+03	No
Carbon Tetrachloride	1.23E-05	2	1.03E+02	7.00E-02	No
Benzene	8.95E-04	2	1.07E+02	1.20E-01	No
Chlorobenzene	1.14E-02	2	1.15E+03	2.00E+01	No
Ethylbenzene	3.70E-02	2	1.45E+03	1.00E+03	No
Tetrachloroethylene	1.26E-04	2	1.13E+03	7.50E-02	No
Styrene	2.47E-05	2	7.10E+02	5.10E+02	No
Toluene	8.33E-03	2	1.26E+03	2.00E+03	No
Xylene (Total)	2.38E-01	2	1.45E+03	3.00E+02	No
Methylene Chloride	9.25E-05	2	5.80E+02	2.70E+01	No
Acetone	5.55E-04	2	5.93E+03	1.40E+04	No

BASED ON THE RESULTS FROM PAGE 4 IT APPEARS THAT THE TLV AND AGC STANDARDS ARE NOT EXEEDED ON THE PROPERTY BOUNDRY.

REFERENCES

1) RI/FS REPORT (APRIL 91)
2) LETTER FROM NYSDEC (K.A. McCue, Project Manager, Bureau of Central Remedial Action) TO J. LANZO, URS RECEIVED JULY 22, 91
3) DRAFT " NYS AIR GUIDE - 1 ", 91 EDITION
4) RI/FS LANDFILL GAS ANALYSIS

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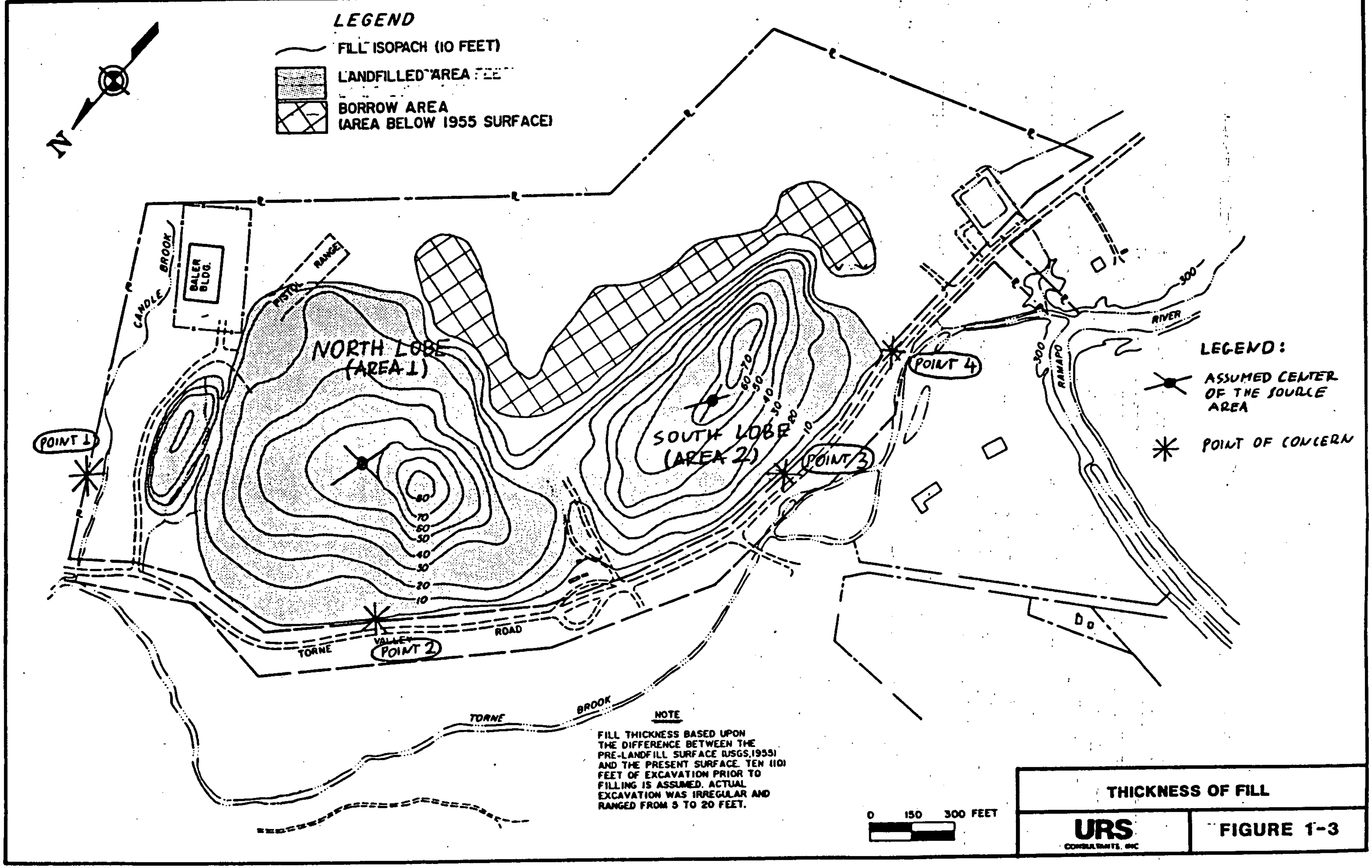
2

REMEDIAL INVESTIGATION
AND
FEASIBILITY STUDY
AT THE
RAMAPO LANDFILL
RAMAPO (T), ROCKLAND (C), NEW YORK

April 1991

Prepared for:

TOWN OF RAMAPO, NEW YORK



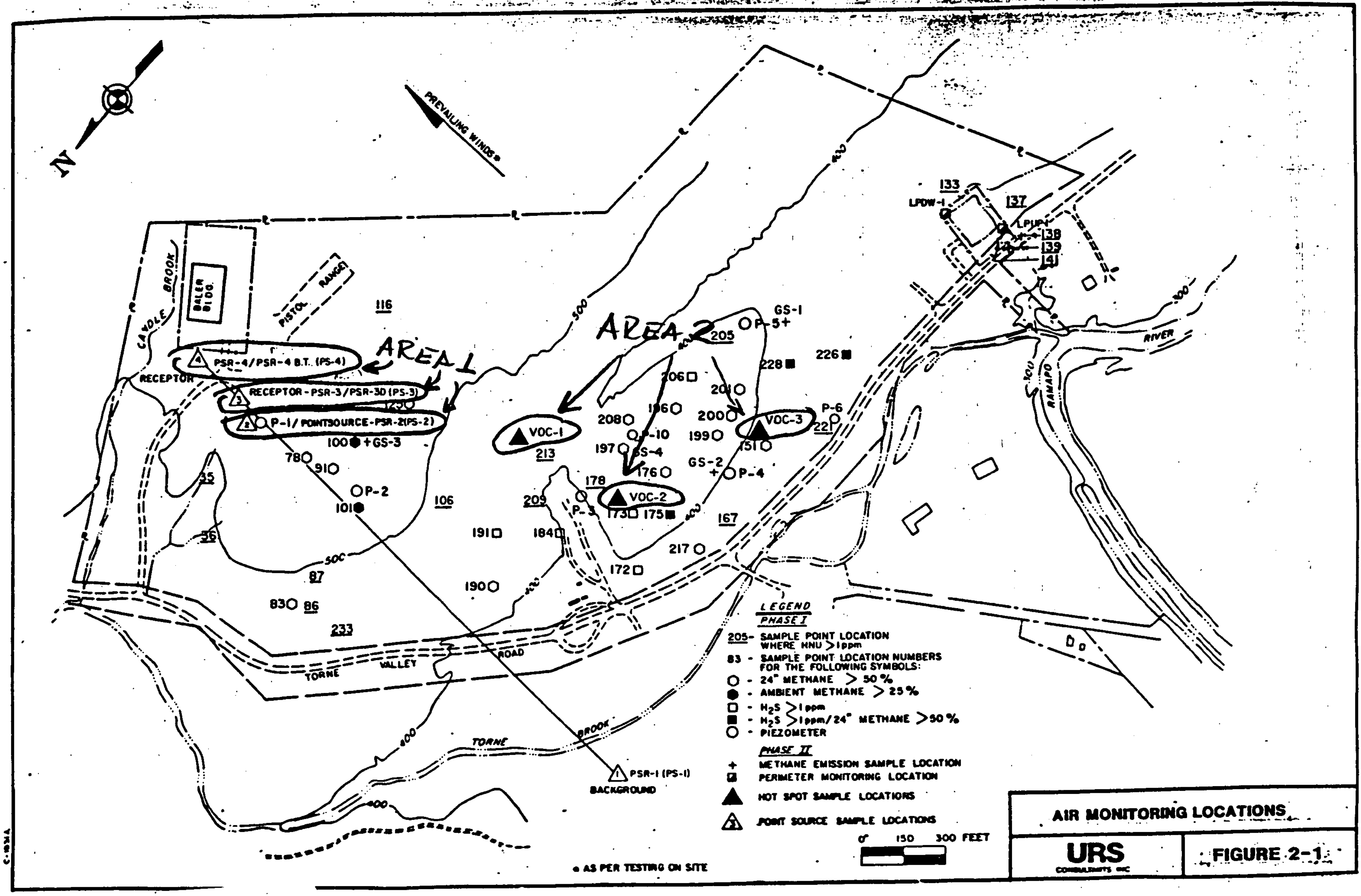
NOTE

FILL THICKNESS BASED UPON THE DIFFERENCE BETWEEN THE PRE-LANDFILL SURFACE (USGS,1955) AND THE PRESENT SURFACE. TEN (10) FEET OF EXCAVATION PRIOR TO FILLING IS ASSUMED. ACTUAL EXCAVATION WAS IRREGULAR AND RANGED FROM 5 TO 20 FEET.

THICKNESS OF FILL

URS

FIGURE 1-3



AIR MONITORING LOCATIONS

URS CONSULTANTS INC

FIGURE 2-1

TABLE 4-23

Phase II
Air Monitoring Program
VOA Analytical Summary
Ramapo Landfill

AREA 2

Parameter	Units	TLV	VOC-1	VOC-2	VOC-3	LPDW-1	LPUP-1	LPTB-1
2 – Butanone	mg/m^3	590	0.0054	0.0079	0.003	0.0031	ND	ND
1,1,1 – Trichloroethane	mg/m^3	1910	ND	0.0008	ND	0.0011	0.0013	ND
Carbon Tetrachloride	mg/m^3	31	ND	0.0002 J	ND	0.0007	ND	ND
Benzene	mg/m^3	32	0.0007	0.0006	0.0003 J	0.0008	0.001	ND
Chlorobenzene	mg/m^3	345	ND	0.0005	ND	ND	ND	ND
Ethylbenzene	mg/m^3	434	ND	0.0026	0.0008	ND	0.0009	ND
Tetrachloroethylene	mg/m^3	339	ND	ND	ND	ND	ND	ND
Styrene	mg/m^3	213	ND	ND	0.0005	ND	ND	ND
Toluene	mg/m^3	377	0.0079	0.0016	0.0061	0.0017	0.0038	ND
Xylene (Total)	mg/m^3	434	ND	0.011	0.007	0.0025	0.0058	ND
Methylene Chloride	mg/m^3	174	0.0018 B	0.001 B	0.0013 B	0.0023 B	0.001 B	0.0028 B
Acetone	mg/m^3	1780	0.015 B	0.013 B	0.016 B	0.011 B	0.011 B	0.0061 B

NOTE: Samples were analyzed for the complete TCL Volatiles list.

ND - None Detected

TLV - Threshold Limit Value as a Time Weighted Average; American Conference of Industrial Hygienists, 1990 - 1991.

J - Indicates the result is less than the sample quanititation limit but greater than zero.

B - Analyte detected in the associated method blank.

TABLE 4-24

Phase II
Air Monitoring Program
VOA Analytical Summary
Ramapo Landfill

AREA 1

Parameter	Units	TLV	PSR-1	PSR-2	PSR-3	PSR-3D	PSR-4	PSR-4BT	PSR-TB
2 - Butanone	mg/m^3	590	ND	ND	0.0091	0.0075	0.011	0.018	ND
1,1,1 - Trichloroethane	mg/m^3	1910	ND	ND	0.001	0.0007	0.0011	ND	ND
Carbon Tetrachloride	mg/m^3	31	ND	ND	ND	ND	0.0004	ND	ND
Benzene	mg/m^3	32	ND	0.029 E	0.0005	ND	0.0006	ND	ND
Chlorobenzene	mg/m^3	345	ND	0.37 E	0.0007	ND	ND	ND	ND
Ethylbenzene	mg/m^3	434	ND	1.20 E	0.0049	0.0012	0.0009	0.0011	ND
Tetrachloroethylene	mg/m^3	339	ND	0.0041	ND	ND	ND	ND	ND
Styrene	mg/m^3	213	ND	ND	ND	ND	ND	0.0008	ND
Toluene	mg/m^3	377	0.0004 J	0.27 E	0.0011	0.0007	0.0014	0.0013	0.0004 J
Xylene (Total)	mg/m^3	434	ND	7.70 E	0.016	0.0046	0.012	0.016	ND
Methylene Chloride	mg/m^3	174	0.001 B	0.002 B	0.0006 B	0.0013 B	0.0008 B	0.003 B	0.0034 B
Acetone	mg/m^3	1780	0.01 B	0.0057 B	0.012 B	0.010 B	0.011 B	0.018 B	0.012 B

NOTE: Samples were analyzed for the complete TCL Volatiles list.

ND - None Detected

TLV - Threshold Limit Value as a Time Weighted Average; American Conference of Industrial Hygienists, 1990 - 1991.

J - Indicates the result is less than the sample quanititation limit but greater than zero.

E - Estimated value due to interference.

B - Analyte detected in the associated method blank.

FAX MEM
PAGES 2 DATE 7/22/91
TO Jim Lanzo
FROM Kathleen McGue
CO. NYSDEC
PHONE 518 457 1641

New York State Department of Environmental Conservati
50 Wolf Road, Albany, New York 12233 - 7010

Commissioner

JUL 22 1991

Received 7-23
CC: AMr
JL
35207. VI.

Mr. James Lanzo
Project Manager
URS Consultants
282 Delaware Avenue
Buffalo, New York 14202

Dear Mr. Lanzo:

RE: Ramapo Landfill
Site No. 344004

As I mentioned during our telephone conference on July 17, 1991, a screening model for baseline air emissions from municipal landfills has been developed by NYSDEC Division of Air Resources which is based upon soil gas VOC concentrations, a landfill gas generation rate, and the area source model found on Page 21 of Air Guide-1. Although compound-specific soil gas data were not collected, the concentrations of compounds of concern at hot spots such as piezometer P-1, which appear to represent actual subsurface gas composition, may be used in the procedure detailed below.

The recommended procedure for estimating concentrations of VOC's from landfill emissions is as follows:

1. Determine a rate of landfill gas generation for the entire site using the EPA estimate of 220 cubic feet of gas per cubic yard of refuse per year. The refuse volume should include all municipal solid waste disposed of within the last 20 years (in Ramapo's case this is effectively the entire waste volume). "Landfill gas" is assumed to be a 50-50 mixture of methane and carbon dioxide with trace non-methane VOC's.

2. Use highest concentrations of compounds of concern detected (for a worst-case assumption) and the sitewide gas generation rate to obtain a sitewide emission rate for each compound.

3. Using the area-source model described on Page 21 of Air Guide-1, calculate the annual concentrations of compounds at the property line and compare these to Ambient Guideline Concentrations (AGC's). If exceedances are found using the worst-case assumption, some reasonable method of averaging compound emission rates in different portions of the landfill should be used.

As discussed in the draft RI Report, Threshold Limit Values (TLV's) are appropriate for showing risks to workers at the landfill; however, AGC's must be used to show compliance with New York State air quality regulations off the landfill property. The above-described estimation procedure is very conservative and if no exceedances are found using worst-case emission rates or a conservative method of averaging, a good argument can be made that emissions of VOC's to off-site receptors are not of concern. Exceedances obtained using this method will indicate a need for further study, perhaps during remedial design, to verify whether noncompliance exists and what design elements will be needed to control emissions.

Please give me a call if you or your staff need clarification of the above procedure.

Sincerely,

Kathleen A McCue

Kathleen A. McCue
Project Manager
Bureau of Central Remedial Action
Division of Hazardous Waste
Remediation

cc: G. Ostertag

13
of
20

New York State Department of Environmental Conservation

DRAFT

New York State Air Guide-1

GUIDELINES For The Control of Toxic Ambient Air Contaminants

Division of Air Resources

1991 Edition

14 of 21

III.A.3. Calculate the maximum Potential Annual Impact, C_p, from the point source using the effective stack height, h_e, and the reported hourly emission rate, Q, in the equation below:

$$C_p \text{ (ug/m3)} = \frac{4218 \; Q}{h_e^{2.16}}$$

where Q is in lbs/hour; h_e in feet.

Permit conditions restricting the hours per year of operation should be considered if, $C_p > AGC$ but, $C_a < AGC$.

III.A.3.a. As an alternative, the maximum Actual and Potential Annual Impacts (C_a & C_p), from the point source can be calculated using Figure B-2. This figure shows the maximum potential annual impact from a 1 lb/hr source for different effective stack heights, h_e. As this value is on a 1 lb/hr basis, multiply by the factors below to determine the impacts.

$$C_a \text{ (ug/m3)} = C_{p1} \; Q_a/8760$$

$$C_p \text{ (ug/m3)} = C_{p1} \; Q$$

where Q is the reported hourly emission rate in lbs/hour and Q_a, the annual emission rate in lbs/year.

III.A.4. Calculate the maximum Short-Term Impact, C_{ST}, from the point source using the equation below:

$$C_{ST} \text{ (ug/m3)} = C_p \; 420$$

where C_p is the maximum Potential Annual Impact as defined above.

III.A.4.a If the stack height to building height ratio (h_s/h_b) is greater than 2.5 then, reduce C_{ST} by half to account for the GEP stack.

III.B. AREA SOURCE METHOD

This method may be used to determine the maximum actual annual, potential annual and short-term impacts from an area source at a specified downwind distance. That specified downwind distance must be outside the area source. When there are multiple area and/or point sources, the impacts should be summed. This procedure was developed primarily for ground level sources meeting the general source characteristics specified in Section IV.G.

III.B.1. Determine the side length, S, of the area source in feet. The area source should be square. The side length, S, should be greater than 30 feet but less than 3300 feet.

III.B.2. Determine the distance, D, from the center of the area source to the desired point of impact in feet. For most permittin applications, assume D equal to the distance to the propert line, D_{pl}. The desired point of impact must be outside th area source. More precisely, D, must be greater that th effective radius of the area source, R_e, as defined below:

$$R_e \text{ (feet)} = 0.56 \text{ S}$$

where S (feet) is the side length of the area source, define above.

III.B.3. Determine the height, h_A, of the area source in feet. Assume this to be the release height of the pollutant. The ar source height should be less than 100 feet. For ground lev sources assume h_A equals 3 feet.

III.B.3.a. For area source heights, h_A, greater than 3 feet, the equations below over-predict the impacts closest to t source. This conservatism is most pronounced f distances, D, less than D_{max}, where D_{max} is t approximate distance to maximum impact for a given ar source height as defined below:

$$D_{max} \text{ (feet)} = 9.84 \; (h_A)^{1.15}$$

where h_A is the height of the area source in feet.

If D is less than D_{max}, substitute D_{max} for D in t equations below.

III.B.4. Calculate the maximum Actual Annual Impact, C_a, from the ar source at the desired point of impact (distance D), using equation below:

$$C_a \text{ (ug/m3)} = \frac{104 \cdot Q_a}{(D+S)^{1.6} \quad h_A^{\;0.368}}$$

where Q_a is the annual emission rate in lb/year, and D, S an h_A as defined above.

III.B.5. Calculate the maximum Potential Annual Impact, C_p, from the area source at the desired point of impact (distance D), us the equation below:

$$C_p \text{ (ug/m3)} = \frac{914000 \quad Q}{(D+S)^{1.6} \quad h_A^{\;0.368}}$$

where Q is the hourly emission rate in lb/hr, and D, S anc as defined above.

III.B.5. Calculate the maximum Short-Term Impact, C_{ST}, from the area source using the equation below:

$$C_{ST}\ (ug/m3) - C_p\ \ 100.$$

where C_p is the maximum Potential Annual Impact as defined above.

III.C. ALTERNATE AREA SOURCE METHOD

The following alternate area source method was developed specifically for remediation projects and urban scale emissions. It has the flexibility to permit the calculation of the maximum annual concentration <u>within</u> an area source. Annual impacts may be estimated both within and downwind from an area source. However, the method has not been modified to estimate short-term impacts. The method will perform better the closer the source characteristics and assumptions approximate those specified in Section IV.G. The contribution from nearby area sources can be calculated by the procedures outlined below. Only sources located within a distance of 3S (S is the length of a side of the area source) from the source being analyzed need be considered. The method can calculate impacts at receptor distances from the source boundary to a distance of 2.5S from the area source. This range encompasses practically all cases of interest in these types of applications.

The following procedures are valid for ground level area sources, effectively less than 10 feet in height, with side lengths greater than 330 feet:

III.C.1. Determine the area source emission rate (Q_A) in units of $lb/(hr\text{-}ft^2)$ by dividing the total annual emission rate, Q_a (lb/hr), by the area, A (ft^2), of the source.

$$Q_A \frac{(\ lb\ )}{(hr\text{-}ft^2)} - \frac{(\text{emission rate})}{(\text{area})} - \frac{Q_a}{A}$$

III.C.2. Calculate the maximum Actual Annual Impact, C_a, <u>within</u> the area source as defined below:

$$C_a(ug/m^3) - K\quad Q_A\quad C_m$$

Where: K_1 - 15 for 330 ft $\leq$ S< 3300 ft
K - 30 for S $\geq$ 3300 ft
C_m - 1.355 x 10^6, a conversion factor from $lb/(hr\text{-}ft^2)$ to ug/m^2-sec).

III.C.3. If the receptors of interest are located off-site and are from one to 2.5 times the side length of the area source away, divide the concentration calculated in Step III.C.2. by the following factors:

Receptor Downwind Distance	S	1.5S	2S	2.5S
Concentration Reduction Factor	7	20	25	35

III.C.4. If there are other area sources within 3S distances from the source being considered, (ideally contiguous to the source being analyzed) then the contribution of these sources can be determined by redefining Q_A in Step III.C.2. (lb/(hr-ft^2) as:

$$Q_A - (Q_{A0} + .32Q_{A1} + .18Q_{A2} + .13Q_{A3})$$

Where Q_{A0} represents the emissions from the source under consideration and Q_{A1} to Q_{A3} represent emissions from sources (if they exist) which are at <u>upwind</u> distances of 1S, 2S, and 3S respectively, from the Q_{A0} source. It must be noted that the nearby sources are assumed to have about the same size as the source under consideration.

III.D. AMBIENT IMPACT EVALUATION METHOD

An ambient air quality impact assessment is required as part of the Appendix B screening procedure. That assessment requires a comparison of predicted worst case annual and short-term impacts to the appropriate standards or guideline values. When building cavity impacts exceed the ambient impacts calculated using the Section III methodologies, those cavity concentrations becom critical for determining the appropriate Environmental Rating unde 6NYCRR Part 212.

It is important to understand that the Appendix B screening method are generally conservative. This is especially true for the short-term impact hand calculation methods. When hand calculated impacts exceed the appropriate standards or guideline values, the AG-1 software program and/or SCREEN model should be used to reduce that conservatism. The SCREEN model should be used as the last step in the short-term impact screening procedure before a refined air quality impact analysis (III.D.1.) should be required.

When there are multiple sources of a contaminant and a grea separation between sources, the conservatism in the short-ter methods may be pronounced. In such a case, summing short-ter impacts may be unrealistically conservative. That level o conservatism increases with greater variations in stack heights an source separation. Source separation becomes critical when i would be impossible for all sources to impact the point of maximu concentration for a given wind direction. When assessing annua impacts, the consideration of multiple sources is not as critica because wind direction varies <u>over a yearly period</u>. Therefore

IV.F. Multiple Point Source Impacts.

The procedures described in Section III perform initial and conservative impact calculations followed by a source specific summation of impacts. The calculations using source specific emission parameters add the maximum impacts from each source t determine the total impact regardless of spatial considerations. These impacts could be overly conservative under such conditions a a large separation between sources (e.g. over 100 meters), a facto of two or more variation in stack heights (especially for stack below 30 meters) and non-alignment of all sources with th predominant wind direction for the given area. In these instance a site specific analysis may predict a significantly lower impact Additionally, if the impact of concern is not at the point o maximum concentration, but at a location where downwind distance o wind direction frequency could influence the impact, then a sit specific model may provide a more accurate and lower impac estimate. Furthermore, if it is determined that the facilit source configuration is too complex for these screening procedure a refined site specific analysis can be requested of the sour owner. BIAM staff should be contacted for guidance on this or a other consideration.

IV.G. Area Sources.

An area source can be used to model many different types of sourc including stack emissions. However, in general, stack emissio should not be modeled as area sources. Area sources best descri emissions uniformly distributed over an area, such as fugiti emissions from a coal pile or from a sewage treatment plant lago For the purposes of this screening model, area sources can be u to model waste disposal sites, fugitive and primary facility-w emissions and urban area sources.

Two different procedures are presented in Section III to estimat the ambient impacts from area sources. Both procedures are usefu although the impact equation in the first method is more flexible The second, alternate method has the advantage of permitting th calculation of the ambient impact within the area source.

Both these methods will perform more accurately the closer source characteristics approximate the following conditions:

1) The emissions in the area source are uniformly distributed with variations not exceeding 25%.

2) The area source is square. If it is not square, it should be broken up into smaller square sources approximated by a square source with an equivalent ar

3) The emissions are continuous and not a function of meteorological conditions.

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RAMAPO LANDFILL RI/FS
TOWN OF RAMAPO, NEW YORK
LANDFILL GAS ANALYSIS

INTRODUCTION

The Landfill Gas Analysis task of the Ramapo Landfill Feasibility Study consisted of three primary activities:

- o Detailed Review of Existing Data
- o Estimation of Landfill Gas Quantity/Quality
- o Evaluation/Conceptual Design of Remedial Alternatives

The work performed as part of each activity is described below, followed by a discussion of the recommended alternative, passive venting.

DETAILED REVIEW OF EXISTING DATA

In order to adequately assess the existing landfill gas (LFG) situation and make reasonable estimates of future conditions, the available data concerning the landfill and LFG was collected and reviewed. This material included:

- o The Preliminary Draft Remedial Investigation Report
- o The Phase I & II Air Monitoring Results
- o The Preliminary Draft Feasibility Study Report
- o The Landfill Gas Recovery Preliminary Site Evaluation Report (prepared previously for the National Gas & Electric Corporation of America)
- o Part 360, Solid Waste Management Facilities, of Title 6, NYCRR

This data provided the basis for the calculations and analyses discussed below.

ESTIMATION OF LANDFILL GAS QUANTITY/QUALITY

The three primary alternatives to be considered for handling the LFG at the Ramapo Landfill were:

- o Passive Venting
- o Collection and Flaring
- o Recovery and Utilization

The key components of such an alternatives analysis are the quantity and quality of LFG being generated. The quantity of LFG available influences the sizes and capacities of any equipment installed and determines whether there is sufficient gas for consideration of collection or recovery. The quality of LFG being generated provides insights into the general "age" of the landfill with respect to LFG production and indicates what types of equipment may be necessary for collection and recovery purposes.

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For the Ramapo Landfill site, the LFG quantity and quality was estimated using a combination of field data and theoretical calculations. The field data was generated primarily during the work to prepare the Remedial Investigation report and includes the monitoring well and air sampling results. The calculations are based on both studies and reports from actual LFG collection installations concerning the quantities of LFG to be expected from specific amounts of solid waste. The calculations were used since no actual pumping tests or other LFG quantity tests were performed at the site. The data sources used for the calculations are listed in the References.

LFG Quantity

Landfill gas quantity estimates were calculated using gas generation factors derived from both laboratory studies and actual field installations. The calculations are summarized below and shown completely on the calculation sheets included in the Appendix. The quantity estimates are as follows:

I. North Lobe

1. Size - 32 Acres
2. Estimated Refuse Volume - 1,350,400 yd^3
3 Estimated Refuse Weight - 6.75×10^8 lbs (@ 500 lbs/yd^3)
4. Estimated LFG Production - 250 ft^3/min (@ 0.19 $ft^3/lb/yr$)

II. South Lobe

1. Size - 16 Acres
2. Estimated Refuse Volume - 618,000 yd^3
3. Estimated Refuse Weight - 3.1×10^8 lbs (@ 500 lbs/yd^3)
4. Estimated LFG Production - 110 ft^3/min (@ 0.19 $ft^3/lb/yr$)

A total of about 350 - 400 ft^3/min of LFG can, therefore, be expected from the Ramapo Landfill. This number can be expected to fluctuate based on weather conditions and the increasing age of the landfill. Since the landfill closed in 1984, appreciable quantities of LFG can be expected to exist until at least the year 2005 to 2010.

LFG Quality

The LFG samples taken during the Phase I & II Air Monitoring efforts provided some data concerning the quality of LFG being produced.

During Phase I, methane concentrations were monitored at a depth of 24 inches at 240 locations around the landfill site. Since methane typically makes up about 50 percent of the LFG produced, it is a good indicator of both the presence of LFG and the stage of gas generation that the landfill is in. Methane is also the primary LFG constituent of concern because of the potential damage to adjacent buildings and property.

APPENDIX Q

HEALTH RISK ASSESSMENT DATA

HEALTH RISK ASSESSMENT DATA

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1.1 Exposure Concentrations Derived Directly From Onsite Monitoring Data

Purpose: A number of potential exposure pathways involve direct exposure to contaminants in onsite media. Under the current use scenario, these pathways include the following: 1) ingestion of contaminated onsite soil/waste; 2) dermal absorption of contaminants in onsite soil/waste; 3) and inhalation of vapors volatilizing from the landfill. Under the future use scenario, four potential pathways, i.e. the three pathways described above and ingestion of groundwater, involve direct exposure to contamination in onsite media.

Most often, the concentration term used in the intake equation for these pathways is the arithmetic average of the concentration that is detected in the medium. However, because of the uncertainty associated with any estimate of exposure concentration, statistical methods were utilized to develop an upper bound limit on the average which was then used as the exposure concentration.

Methodology: In the baseline health risk assessment, the exposure concentration used to assess the risk associated with direct exposure to onsite media is the 95th percent upper confidence limit on the arithmetic average of samples collected from the media. This upper confidence value is calculated based on methodology described in Statistical Methods for Environmental Pollution Monitoring by Richard O. Gilbert utilizing the following equation:

$$UL_{95} = X + t_{95,n-1} \frac{\sqrt{s}}{\sqrt{n}}$$

Where:

UL_{95} = 95th percent Upper Confidence Limit on the Arithmetic Average.

X = Arithmetic Average

$t_{95,n-1}$ = Quantile of the t Distribution for the Probability and Degrees of Freedom Specified

s = Standard Deviation
n = Number of Measurements

To determine the upper confidence value for each analyte studied, half the sample quantitation limit was utilized for samples where the analyte was not detected. Therefore, where analytes were detected infrequently, the upper confidence value sometimes exceeded the maximum concentration detected. If the upper confidence value exceeded the maximum concentration, the maximum concentration was utilized as the exposure concentration.

Results: Exposure concentrations for onsite soil, using all samples except background (SPS-9) and a sample which has been removed (SPS-5), are presented in Table 1. Exposure concentrations in air calculated from air, monitoring data, are presented in Table 2. Exposure concentrations based on monitoring data from all overburden and bedrock monitoring wells used to assess exposure to groundwater under the future land use scenario are presented in Table 3.

1.2 Exposure Concentrations Derived From Contaminant Transport Model

Purpose: Onsite groundwater is not currently being used as a potable water supply source. However, there are residential areas located near the site and downgradient of the site (within 1200 feet) that are utilizing groundwater as a potable supply source. Since there is potential for contamination of downgradient wells resulting from migration of contamination from the landfill, a transport model was developed to determine the impact of the landfill on those nearby downgradient private wells.

Methodology: Horizontal flow from the landfill in the upper (overburden) aquifer is intercepted by Torne Brook and does not appear to be impacting downgradient wells. Therefore, the groundwater transport model consisted of three elements: 1) vertical migration of

TABLE 1

Representative Concentrations for Onsite Surficial Soil

Ramapo Landfill Site

SAMPLE-ID		SPS-1	SPS-2	SPS-3	SPS-4	SPS-6	SPS-7	SPS-8	SPS-10	LSMW10	AVG	STD DEV	n	SQRT n	(n-1)	t(0.95)	UL(95)	max. conc.	value used
PARAMETER	TYPE																		
1,4-Dichlorobenzene	SEMI	190	195	200	370	185	190	195	190	210	213.889	58.990	9	3.000	8	1.860	250.463	370	250.463
1,2-Dichlorobenzene	SEMI	190	195	200	94	185	190	195	190	210	183.222	34.237	9	3.000	8	1.860	204.449	94	94.000
Benzoic Acid	SEMI	190	950	950	1750	900	920	940	210	1000	867.778	462.379	9	3.000	8	1.860	1154.453	210	210.000
Naphthalene	SEMI	190	195	200	1100	185	190	195	190	210	295.000	301.962	9	3.000	8	1.860	482.217	1100	482.217
2-Methylnaphthalene	SEMI	190	195	200	200	185	190	195	190	210	195.000	7.500	9	3.000	8	1.860	199.650	200	199.650
Acenaphthene	SEMI	190	195	200	190	185	190	195	190	210	193.889	7.407	9	3.000	8	1.860	198.481	190	190.000
Dibenzofuran	SEMI	190	195	200	150	185	190	195	190	210	189.444	16.478	9	3.000	8	1.860	199.661	150	150.000
Fluorene	SEMI	190	195	200	170	185	190	195	190	210	191.667	10.897	9	3.000	8	1.860	198.423	170	170.000
N-nitrosodiphenylamine	SEMI	190	195	200	110	185	190	195	190	210	185.000	29.047	9	3.000	8	1.860	203.009	110	110.000
Phenanthrene	SEMI	190	230	81	390	90	190	195	190	66	180.222	98.756	9	3.000	8	1.860	241.451	390	241.451
Anthracene	SEMI	190	43	200	365	185	190	195	190	210	196.444	80.940	9	3.000	8	1.860	246.627	43	43.000
Fluoranthene	SEMI	190	440	160	130	150	190	195	64	130	183.222	104.695	9	3.000	8	1.860	248.133	440	248.133
Pyrene	SEMI	190	310	130	130	130	190	195	73	110	162.000	69.154	9	3.000	8	1.860	204.875	310	204.875
Butylbenzylphthalate	SEMI	190	195	130	365	100	190	195	160	210	192.778	73.829	9	3.000	8	1.860	238.552	160	160.000
Benzo(a)anthracene	SEMI	190	200	84	365	79	190	195	42	64	156.556	101.255	9	3.000	8	1.860	219.334	200	200.000
Chrysene	SEMI	190	230	99	365	81	190	195	64	77	165.667	97.293	9	3.000	8	1.860	225.989	230	225.989
Bis(2-ethylhexyl)phthalate	SEMI	190	195	48	480	160	190	195	320	45	202.556	133.098	9	3.000	8	1.860	285.076	480	285.076
Di-n-octylphthalate	SEMI	190	195	200	365	185	190	195	43	210	197.000	80.907	9	3.000	8	1.860	247.163	43	43.000
Benzo(b)fluoranthene	SEMI	190	170	84	77	140	190	195	73	64	131.444	56.609	9	3.000	8	1.860	166.542	170	166.542
Benzo(k)fluoranthene	SEMI	190	180	71	72	91	190	195	61	72	124.667	61.400	9	3.000	8	1.860	162.735	180	162.735
Benzo(a)pyrene	SEMI	190	160	77	365	92	190	195	62	63	154.889	97.044	9	3.000	8	1.860	215.056	160	160.000
Indeno(1,2,3-cd)pyrene	SEMI	190	140	61	365	185	190	195	93	45	162.667	95.868	9	3.000	8	1.860	222.105	140	140.000
Benzo(g,h,i)perylene	SEMI	190	130	52	365	48	190	195	100	210	164.444	97.519	9	3.000	8	1.860	224.906	130	130.000

One-half the sample quantitation limit (SQL) was used for non-detects.

All values are in ppb.

TABLE 1 (continued)

Representative Concentrations for Onsite Surficial Soil

Ramapo Landfill Site

SAMPLE-ID		SPS-1	SPS-2	SPS-3	SPS-4	SPS-6	SPS-7	SPS-8	SPS-10	LSMW10	AVG	STD DEV	n	SQRT n	(n-1)	t(0.95)	UL(95)	max. conc.	value used
PARAMETER	TYPE																		
2-Butanone	VOC	5.5	5.5	5.5	190	5.5	6	6	5.5	6.5	26.222	61.418	9	3.000	8	1.860	64.301	190	64.301
Benzene	VOC	2.5	2.5	3	42	3	3	3	3	3	7.222	13.043	9	3.000	8	1.860	15.309	42	15.309
1,1,2,2-Tetrachloroethane	VOC	2.5	2.5	2	14.5	3	3	3	3	3	4.056	3.933	9	3.000	8	1.860	6.494	2	2.000
Chlorobenzene	VOC	2.5	2.5	3	730	3	3	3	3	3	83.667	242.375	9	3.000	8	1.860	233.939	730	233.939
Ethylbenzene	VOC	2.5	2.5	3	260	3	3	3	3	3	31.444	85.709	9	3.000	8	1.860	84.584	260	84.584
Total xylenes	VOC	2.5	2.5	3	570	3	3	3	3	3	65.889	189.042	9	3.000	8	1.860	183.095	570	183.095
Dieldrin	PEST	9	46.5	47	18	3.4	9	9.5	9	10	17.933	16.754	9	3.000	8	1.860	28.321	3.4	3.400
Chlordane	PEST	45.5	235	235	90	20	45.5	47.5	45.5	4.5	85.389	87.903	9	3.000	8	1.860	139.889	20	20.000
Heptachlor Epoxide	PEST	4.6	23.5	26	9	22.5	4.6	4.8	4.6	5	11.622	9.430	9	3.000	8	1.860	17.469	26	17.469
Beryllium	MCP	180	240	180	440	170	170	180	180	450	243.333	116.297	9	3.000	8	1.860	315.437	240	240.000
Cadmium	MCP	1200	680	730	1700	1700	840	730	740	3700	1335.556	977.115	9	3.000	8	1.860	1941.367	1700	1700.000
Total phenols	MCP	290	280	290	3560	280	280	290	300	280	650.000	1091.272	9	3.000	8	1.860	1326.589	3560	1326.589
Mercury	MCP	50	55	55	135	50	50	55	50	55	61.667	27.613	9	3.000	8	1.860	78.787	210	7.000

One-half the sample quantitation limit (SQL) was used for non-detects.

All values are in ppb.

TABLE 2

Representative Concentrations for Ambient Air

Ramapo Landfill Site

SAMPLE-ID		VOC-1	VOC-2	VOC-3	LPDW-1	LPUP-1	PSR-2	PSR-3	PSR-4	AVG	STD DEV	n	SQRT n	(n-1)	t(0.95)	UL(95)	max. conc.	value used
PARAMETER	TYPE																	
2-Butanone	VOC	5.40E-03	7.90E-03	3.00E-03	3.10E-03	5.00E-04	5.00E-04	9.10E-03	2.90E-02	4.21E-03	3.40E-03	7	2.6458	6	1.860	6.60E-03	2.90E-02	6.60E-03
1,1,1-Trichloroethane	VOC	2.00E-04	8.00E-04	2.00E-04	1.10E-03	1.30E-03	2.00E-04	1.00E-03	1.30E-03	6.86E-04	4.78E-04	7	2.6458	6	1.860	1.02E-03	1.30E-03	1.02E-03
Carbon Tetrachloride	VOC	2.00E-04	2.00E-04	2.00E-04	7.00E-04	2.00E-04	2.00E-04	2.00E-04	6.00E-04	2.71E-04	1.89E-04	7	2.6458	6	1.860	4.04E-04	7.00E-04	4.04E-04
Benzene	VOC	7.00E-04	6.00E-04	3.00E-04	8.00E-04	1.00E-03	2.90E-02	5.00E-04	8.00E-04	4.70E-03	1.07E-02	7	2.6458	6	1.860	1.22E-02	2.90E-02	1.22E-02
Chlorobenzene	VOC	2.00E-04	5.00E-04	2.00E-04	2.00E-04	2.00E-04	3.70E-01	7.00E-04	4.00E-04	5.31E-02	1.40E-01	7	2.6458	6	1.860	1.51E-01	3.70E-01	1.51E-01
Ethylbenzene	VOC	2.00E-04	2.60E-03	8.00E-04	2.00E-04	9.00E-04	1.20E+00	4.90E-03	2.00E-03	1.73E-01	4.53E-01	7	2.6458	6	1.860	4.91E-01	1.20E+00	4.91E-01
Tetrachloroethene	VOC	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	4.10E-03	2.00E-04	4.00E-04	7.57E-04	1.47E-03	7	2.6458	6	1.860	1.79E-03	4.10E-03	1.79E-03
Styrene	VOC	2.00E-04	2.00E-04	5.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	1.00E-03	2.43E-04	1.13E-04	7	2.6458	6	1.860	3.23E-04	1.00E-03	3.23E-04
Toluene	VOC	7.90E-03	1.60E-03	6.10E-03	1.70E-03	3.80E-03	2.70E-01	1.10E-03	2.70E-03	4.17E-02	1.01E-01	7	2.6458	6	1.860	1.13E-01	2.70E-01	1.13E-01
Xylene (Total)	VOC	2.00E-04	1.10E-02	7.00E-03	2.50E-03	5.80E-03	7.70E+00	1.60E-02	2.80E-02	1.11E+00	2.91E+00	7	2.6458	6	1.860	3.15E+00	7.70E+00	3.15E+00
Methylene Chloride	VOC	1.80E-03	1.00E-03	1.30E-03	2.30E-03	1.00E-03	2.00E-03	6.00E-04	3.80E-03	1.43E-03	6.18E-04	7	2.6458	6	1.860	1.86E-03	2.30E-03	1.86E-03
Acetone	VOC	1.50E-02	1.30E-02	1.60E-02	1.10E-02	1.10E-02	5.70E-03	1.20E-02	2.90E-02	1.20E-02	3.36E-03	7	2.6458	6	1.860	1.43E-02	2.90E-02	1.43E-02

One-half the sample quantitation limit (SQL) was used for non-detects

All values are in mg/m^3

TABLE 3

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-1						GW-2						GW-3					
COLLECTION DATE		S		I		R		S		I		R		S		I		R	
PARAMETER	TYPE																		
Benzene	VOC	2.5	0.5	2.5	0.3	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
Tetrachloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
Trichloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
1,4-Dichlorobenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Isopropylbenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Total Xylene	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
Dichlorodifluoromethane	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Acetone	VOC	5	0.5	5	0.5	5	0.5	5	0.5	5	28	5	0.5	5	0.5			5	0.5
Toluene	VOC	2.5	0.5	2.5	0.3	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
1,1-Dichloroethane	VOC	2.5	0.5	2.5	0.5	2.5	0.8	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
1,2-Dichloroethane	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
p-Isopropyltoluene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
cis-1,2-Dichloroethene	VOC	2.5	0.5	2.5	0.3	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
1,2,4-Trimethylbenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Carbon Disulfide	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
Propylbenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Chloromethane	VOC	5	0.5	5	0.5	5	0.5	5	0.5	5	2.3	5	0.5	5	0.5			5	0.5
Chlorobenzene	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
Styrene	VOC	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.5			2.5	0.5
1,2-Dichlorobenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
1,3,5-Trimethylbenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
4-Methyl-2-Pentanone	VOC	5	0.5	4	0.5	3	0.5	5	0.5	5	0.5	5	0.5	5	0.5			5	0.5
tert-Butylbenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-4						GW-6						GW-7					
COLLECTION DATE		S		I		R		S		I		R		S		I		R	
PARAMETER	TYPE																		
Benzene	VOC	2.5	0.3	2	1	1	1		0.5		0.2		0.5	2.5	0.5	2.5	0.3	2.5	0.5
Tetrachloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.6		0.5	2.5	0.5	2.5	0.5	2.5	0.5
Trichloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.2		0.5	2.5	0.5	2.5	0.5	2.5	0.5
1,4-Dichlorobenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Isopropylbenzene	VOC		0.5		0.5		0.5		0.5		0.4		0.5		0.5		0.5		0.5
Total Xylene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		1.7		0.5	2.5	0.5	2.5	0.5	2.5	0.5
Dichlorodifluoromethane	VOC		0.5		0.5		0.2		0.5		0.5		0.5		0.5		0.5		0.5
Acetone	VOC	5	0.5	5	0.5	5	0.5		21		0.5		0.5	5	0.5	5	0.5	5	0.5
Toluene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.7		0.3		0.3	2.5	0.5	2.5	0.5	2.5	0.5
1,1-Dichloroethane	VOC	2.5	0.5	2.5	2.8	5	2.1		0.5		0.5		0.5	2.5	0.5	2.5	0.5	2.5	0.5
1,2-Dichloroethane	VOC	2.5	0.5	2.5	0.2	2.5	0.1		0.5		0.5		0.5	2.5	0.5	2.5	0.5	2.5	0.5
p-Isopropyltoluene	VOC		0.5		0.5		0.5		0.5		1.2		0.5		0.5		0.5		0.5
cis-1,2-Dichloroethene	VOC	2.5	0.5	2.5	0.1	2.5	0.1		0.5		0.1		0.5	2.5	0.5	2.5	0.5	2.5	0.5
1,2,4-Trimethylbenzene	VOC		0.5		0.8		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Carbon Disulfide	VOC	2.5	0.5	2.5	0.5	2	0.5		0.5		0.5		0.5	2.5	0.5	2.5	0.5	2.5	0.5
Propylbenzene	VOC		0.5		0.5		0.5		0.5		0.4		0.5		0.5		0.5		0.5
Chloromethane	VOC	5	0.5	3	0.5	5	0.5		0.5		0.5		0.5	3	0.5	5	0.5	5	0.5
Chlorobenzene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5	2.5	0.5	2.5	0.5	2.5	0.5
Styrene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.6		0.5	2.5	0.5	2.5	0.5	2.5	0.5
1,2-Dichlorobenzene	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
1,3,5-Trimethylbenzene	VOC		0.5		1.9		0.5		0.5		1.9		0.5		0.5		0.5		0.5
4-Methyl-2-Pentanone	VOC	5	0.5	5	5	5	0.5		0.5		5		0.5	5	0.5	5	0.5	5	0.5
tert-Butylbenzene	VOC		0.5		0.5		0.5		0.5		0.4		0.5		0.5		0.5		0.5

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-8						GW-9						GW-10						GDT-1
COLLECTION DATE		S		I		R		S		I		R		S		I		R		S
PARAMETER	TYPE																			
Benzene	VOC	2	0.3	2	2.9	3	0.4		0.5		0.2		0.9		0.5				0.5	0.5
Tetrachloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.6
Trichloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
1,4-Dichlorobenzene	VOC		1.1		0.5		0.5		0.5		0.5		0.5		0.5				0.5	0.5
Isopropylbenzene	VOC		0.5		3.7		0.5		0.5		0.5		1		0.5				0.5	0.5
Total Xylene	VOC	2.5	0.5	2.5	0.7	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
Dichlorodifluoromethane	VOC		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5	0.5
Acetone	VOC	5	0.5	5	0.5	5	35		0.5		0.5		23		0.5				0.5	0.5
Toluene	VOC	2.5	0.5	1	0.6	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
1,1-Dichloroethane	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
1,2-Dichloroethane	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
p-Isopropyltoluene	VOC		0.5		1.7		0.5		0.5		0.5		1.2		0.5				0.5	0.5
cis-1,2-Dichloroethene	VOC	2.5	0.5	2.5	0.5	2.5	0.9		0.5		0.5		0.5		0.5				0.5	0.5
1,2,4-Trimethylbenzene	VOC		0.5		1.4		0.5		0.5		0.5		0.5		0.5				0.5	0.5
Carbon Disulfide	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
Propylbenzene	VOC		0.5		0.8		0.5		0.5		0.5		0.5		0.5				0.5	0.5
Chloromethane	VOC	5	0.5	3	0.5	5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
Chlorobenzene	VOC	1	1.2	3	16	2.5	1.8		0.5		0.5		2		0.5				0.5	0.5
Styrene	VOC	2.5	0.5	2.5	0.5	2.5	0.5		0.5		0.5		0.5		0.5				0.5	0.5
1,2-Dichlorobenzene	VOC		0.5		1.2		0.5		0.5		0.5		0.9		0.5				0.5	0.5
1,3,5-Trimethylbenzene	VOC		0.5		1.8		0.5		0.5		0.5		1.9		0.5				0.5	0.5
4-Methyl-2-Pentanone	VOC	5	0.5	5	5	5	0.5		0.5		0.5		5		0.5				0.5	0.5
tert-Butylbenzene	VOC		0.5		1.5		0.5		0.5		0.5		0.5		0.5				0.5	0.5

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		AVG	STD DEV	n	SQRT n	(n-1)	t(0.95)	UL(95)	max conc.	value used
COLLECTION DATE										
PARAMETER	TYPE									
Benzene	VOC	1.286	0.993	43	6.557	42	1.684	1.541	3	1.541
Tetrachloroethene	VOC	1.295	0.986	43	6.557	42	1.684	1.549	0.6	0.600
Trichloroethene	VOC	1.284	0.996	43	6.557	42	1.684	1.540	0.2	0.200
1,4-Dichlorobenzene	VOC	0.523	0.118	26	5.099	25	1.708	0.562	1.1	0.562
Isopropylbenzene	VOC	0.638	0.633	26	5.099	25	1.708	0.850	3.7	0.850
Total Xylene	VOC	1.323	0.980	43	6.557	42	1.684	1.575	1.7	1.575
Dichlorodifluoromethane	VOC	0.488	0.059	26	5.099	25	1.708	0.508	0.2	0.200
Acetone	VOC	4.721	7.639	43	6.557	42	1.684	6.683	35	6.683
Toluene	VOC	1.249	0.980	43	6.557	42	1.684	1.500	1	1.000
1,1-Dichloroethane	VOC	1.447	1.130	43	6.557	42	1.684	1.737	5	1.737
1,2-Dichloroethane	VOC	1.274	1.005	43	6.557	42	1.684	1.533	0.2	0.200
p-Isopropyltoluene	VOC	0.600	0.294	26	5.099	25	1.708	0.698	1.7	0.698
cis-1,2-Dichloroethene	VOC	1.267	1.016	43	6.557	42	1.684	1.528	0.9	0.900
1,2,4-Trimethylbenzene	VOC	0.546	0.184	26	5.099	25	1.708	0.608	1.4	0.608
Carbon Disulfide	VOC	1.279	0.978	43	6.557	42	1.684	1.530	2	1.530
Propylbenzene	VOC	0.508	0.063	26	5.099	25	1.708	0.529	0.8	0.529
Chloromethane	VOC	2.181	2.093	43	6.557	42	1.684	2.719	3	2.719
Chlorobenzene	VOC	1.709	2.431	43	6.557	42	1.684	2.334	16	2.334
Styrene	VOC	1.293	0.988	43	6.557	42	1.684	1.547	0.6	0.600
1,2-Dichlorobenzene	VOC	0.542	0.155	26	5.099	25	1.708	0.594	1.2	0.594
1,3,5-Trimethylbenzene	VOC	0.712	0.506	26	5.099	25	1.708	0.881	1.9	0.881
4-Methyl-2-Pentanone	VOC	2.628	2.228	43	6.557	42	1.684	3.200	3	3.000
tert-Butylbenzene	VOC	0.535	0.198	26	5.099	25	1.708	0.601	1.5	0.601

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-1						GW-2						GW-3					
COLLECTION DATE		S		I		R		S		I		R		S		I		R	
PARAMETER	TYPE																		
Naphthalene	SEMI		0.5		0.5		0.5		0.5		0.5		0.5		0.5				0.5
Diethylphthalate	SEMI	5	5	5	5	5	5	5	5	5	5	5	5	5	5			5	5
Butylbenzylphthalate	SEMI	5	5	5	5	5	5	5	5	5	5	5	5	5	5			5	5
Bis(2-ethylhexyl)phthalate	SEMI	3	5	3	2	5	5	3	5	7	5	2	5	5	2			5	5
Di-n-octylphthalate	SEMI	5	5	5	5	5	5	5	5	5	5	5	5	5	5			5	5
delta-BHC	PEST	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025			0.025	0.025
gamma-BHC	PEST	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025			0.025	0.025
Pyrene	SEMI	5	5	5	5	5	5	5	5	5	5	5	5	5	5			5	5
Aluminum	MCP	18900	7130	1460	7.5	715	1520	321	19000	313	189	426	463	3060	1620			7.5	223
Arsenic	MCP	2.2	2.4	2.2	2.2	2.2	2.2	2.2	4.9	1.1	2.2	2.2	2.2	1.1	2.2			1.1	2.2
Barium	MCP	197	100	44	43	15	22	20	139	11	8	9	9	133	61			47	53
Cadmium	MCP	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4
Calcium	MCP	88200	78800	107000	111000	88500	95600	87200	132000	22100	13800	52100	53400	64300	8700			80100	99400
Chromium	MCP	153	57.3	280	11	39.7	17.5	180	141	20.6	24.3	16.1	5.5	587	1290			28	11.4
Cobalt	MCP	17.8	12.2	12	9.8	12	9	12	42.3	10	9	12	20	10	11			10	19.5
Copper	MCP	78.3	32	9.6	1.5	9.1	14.8	5.6	59.4	1.5	5.1	7.4	5.4	18	17.9			1.5	3.8
Iron	MCP	45000	17500	5300	7180	1180	2650	912	41800	406	532	409	602	6830	9750			1930	1370
Lead	MCP	11.8	6.2	3.5	2.7	2.3	3	2.5	34.1	1.4	4.2	3.9	3	5	5			1.1	2.3
Manganese	MCP	3790	3700	1490	1530	144	98.5	298	4770	82.1	50.5	197	135	8700	18100			7230	12400
Mercury	MCP	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			0.2	0.2
Nickel	MCP	98.7	36.6	162	19	27.4	3	61.8	99.4	28.9	17.6	3	3	331	79.7			18.2	22.2
Potassium	MCP	8120	4660	3050	2640	2160	2320	1050	4820	6620	4770	1250	1260	3190	3280			2360	2360
Sodium	MCP	57700	52900	43700	47400	15300	15000	14200	14900	44800	54600	11400	7210	47100	62300			90900	82100
Vanadium	MCP	51.6	21.8	5	5	5	5	5	40	5	5	5	5	7.8	7.1			5	5
Zinc	MCP	79.3	34.9	18.2	7.9	10.8	15.3	8.2	107	7.2	9.9	20.7	10.6	17.7	11.5			11.9	16

All values reported in ug/l(ppb).

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-4						GW-6						GW-7					
COLLECTION DATE		S		I		R		S		I		R		S		I		R	
PARAMETER	TYPE																		
Naphthalene	SEMI		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5
Diethylphthalate	SEMI	5	5	5	4	3	2		5		5		5	5	5	5	5	5	5
Butylbenzylphthalate	SEMI	5	5	5	5	5	5		5		5		5	5	5	5	5	5	5
Bis(2-ethylhexyl)phthalate	SEMI	5	5	3	5	5	5		5		5		5	5	5	30	2	27	5
Di-n-octylphthalate	SEMI	5	5	5	5	5	5		5		5		5	5	5	5	5	5	5
delta-BHC	PEST	0.025	0.025	1.9	0.025	0.025	0.025		0.025		0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025
gamma-BHC	PEST	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025		0.025	0.025	0.025	0.025	0.025	0.06	0.025
Pyrene	SEMI	5	5	5	5	5	5		5		5		5	5	5	5	5	5	5
Aluminum	MCP	2800	3640	1470	5160	765	321		2950		273		420	679	16100	722	986	154	1270
Arsenic	MCP	2.8	2.2	2.2	2.2	2.2	2.2		2.5		2.2		2.2	2.2	4.3	2.2	2.2	2.2	2.2
Barium	MCP	54	58	44	76	14	10		110		6		10	32	230	16	26	28	25
Cadmium	MCP	4	4	4	4.9	4	4		4		4		4	4	4	4	4	4	4
Calcium	MCP	72000	81400	104000	113000	74700	66300		97800		11500		17800	40100	77600	27900	41900	74300	64900
Chromium	MCP	139	40.1	135	70.6	35.5	13.1		40.1		28.7		31.1	33.5	40.1	106	13.1	16.2	16.8
Cobalt	MCP	12	9	12	9	12	9		25.3		9		9	12	21.9	12	12.4	12	9
Copper	MCP	28.1	17.3	10	20.9	8	1.5		12.7		5.9		10.3	6.1	62.3	4.8	5.8	3.1	7.7
Iron	MCP	15600	12400	12600	24500	8230	5290		10600		486		683	981	24500	1400	3000	24	1940
Lead	MCP	5.2	7.2	3.4	5.3	3	11.4		9.6		1.1		6.4	2.3	8.8	2.9	2.2	1.2	1.7
Manganese	MCP	4210	5020	3500	4500	1730	1520		6770		33.1		14.3	1240	3260	834	631	51.9	102
Mercury	MCP	0.2	0.2	0.2	0.2	0.2	0.2		0.63		2.3		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel	MCP	87.9	23	68.3	44.4	27.9	3		35		22		19.4	28.9	30.7	79.2	21.5	14.7	25.5
Potassium	MCP	2230	3170	3770	4780	1870	1490		10300		1170		1220	7180	31200	2810	1970	3170	2900
Sodium	MCP	35800	56900	64500	75300	20400	15300		23900		4380		5370	61800	84100	54700	52900	21800	21500
Vanadium	MCP	6.8	10	5.3	15.2	5	5		11.1		5		5	5	28.5	5	5	5	5
Zinc	MCP	29.8	20.5	22.8	17.8	33.7	6.2		18.5		8.5		13.4	21	52.4	22.6	15	9.9	13.8

All values reported in ug/l(ppb)

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		GW-8						GW-9						GW-10						GDT-1
COLLECTION DATE		S		I		R		S		I		R		S		I		R		S
PARAMETER	TYPE																			
Naphthalene	SEMI		0.5		4.2		0.8		0.5		0.5		0.3		0.5				0.5	0.5
Diethylphthalate	SEMI	5	5	5	5	5	2		5		5		5		5				5	5
Butylbenzylphthalate	SEMI	5	5	5	5	5	2		5		5		5		5				5	5
Bis(2-ethylhexyl)phthalate	SEMI	5	5	5	5	2	9		5		5		5		5				5	5
Di-n-octylphthalate	SEMI	5	5	5	5	5	130		5		5		5		5				5	5
delta-BHC	PEST	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025		0.025		0.025				0.025	0.025
gamma-BHC	PEST	0.025	0.025	0.025	0.025	0.025	0.025		0.025		0.025		0.025		0.025				0.025	0.025
Pyrene	SEMI	5	5	5	5	5	5		5		3		5		5				5	5
Aluminum	MCP	1960	2260	619	2550	138	1020		165		7.5		7.5		1730				2700	122
Arsenic	MCP	26.1	20.5	1.1	11	1.1	2.2		2.2		2.2		3.1		2.2				2.2	2.2
Barium	MCP	441	122	155	559	14	19		3		3		100		50				24	3
Cadmium	MCP	4	4	4	4	4	4		4		4		4		4				4	4
Calcium	MCP	69100	31500	108000	112000	187000	219000		7300		7860		79700		37000				64000	9260
Chromium	MCP	34.8	16.7	215	32.5	20	23.1		6.8		8.1		8.8		24.5				26.9	5
Cobalt	MCP	10	10.5	10	36.2	10	13.2		9		36.2		10.9		24.7				9	9
Copper	MCP	9.6	13.7	5.1	11.4	1.5	39.3		1.5		3.2		1.5		4.7				11.4	47.4
Iron	MCP	229000	43800	15700	30500	1360	2940		249		145		20200		8320				4390	64
Lead	MCP	3.3	5.1	1.4	3	3	4.5		3.8		1.1		1.1		2.2				2.2	9.2
Manganese	MCP	2830	2750	4230	1110	872	181		14.6		377		3270		31200				110	3
Mercury	MCP	0.2	0.2	0.2	0.28	0.2	2		0.5		0.2		0.2		0.2				0.2	0.29
Nickel	MCP	30	28.1	119	153	3	30.1		3		3		22		26.9				20.6	17
Potassium	MCP	22400	16100	34200	196000	3170	10500		717		807		18600		2340				2510	1070
Sodium	MCP	102000	58400	166000	643000	25900	39600		2250		4460		147000		32900				10700	4360
Vanadium	MCP	5	5	5	19.5	5	5		5.9		5		5		5				6.1	5
Zinc	MCP	11.3	30.7	14.7	23.9	7.7	53.7		5		3.7		5.4		16.2				25.7	11.7

All values reported in ug/l(ppb).

TABLE 3 (continued)

Representative Concentrations for Groundwater

Ramapo Landfill Site

SAMPLE-ID		AVG	STD DEV	n	SQRT n	(n-1)	t(0.95)	UL(95)	max conc.	value used
COLLECTION DATE										
PARAMETER	TYPE									
Naphthalene	SEMI	0.646	0.728	26	5.099	25	1.708	0.890	4.2	0.890
Diethylphthalate	SEMI	4.791	0.709	43	6.557	42	1.684	4.973	5	4.973
Butylbenzylphthalate	SEMI	4.930	0.457	43	6.557	42	1.684	5.048	27	5.048
Bis(2-ethylhexyl)phthalate	SEMI	5.698	5.276	43	6.557	42	1.684	7.053	30	7.053
Di-n-octylphthalate	SEMI	7.907	19.062	43	6.557	42	1.684	12.802	130	12.802
delta-BHC	PEST	0.069	0.286	43	6.557	42	1.684	0.142	1.9	0.142
gamma-BHC	PEST	0.026	0.005	43	6.557	42	1.684	0.027	0.06	0.027
Pyrene	SEMI	4.953	0.305	43	6.557	42	1.684	5.032	3	3.000
Aluminum	MCP	2473.116	4559.678	43	6.557	42	1.684	3644.076	19000	3644.076
Arsenic	MCP	3.416	4.728	43	6.557	42	1.684	4.631	26.1	4.631
Barium	MCP	73.093	110.452	43	6.557	42	1.684	101.458	559	101.458
Cadmium	MCP	4.021	0.137	43	6.557	42	1.684	4.056	4.9	4.056
Calcium	MCP	71607.442	45309.917	43	6.557	42	1.684	83243.373	219000	83243.373
Chromium	MCP	94.037	212.967	43	6.557	42.000	1.684	148.732	1290	148.732
Cobalt	MCP	14.009	7.916	43	6.557	42	1.684	16.042	42.3	16.042
Copper	MCP	14.551	17.737	43	6.557	42	1.684	19.106	78.3	19.106
Iron	MCP	14471.000	35635.452	43	6.557	42	1.684	23622.455	229000	23622.455
Lead	MCP	4.726	5.339	43	6.557	42	1.684	6.097	34.1	6.097
Manganese	MCP	3327.419	5666.135	43	6.557	42	1.684	4782.525	31200	4782.525
Mercury	MCP	0.312	0.420	43	6.557	42	1.684	0.419	2.3	0.419
Nickel	MCP	46.479	59.042	43	6.557	42	1.684	61.641	162	61.641
Potassium	MCP	10268.698	29982.079	43	6.557	42	1.684	17968.323	196000	17968.323
Sodium	MCP	58063.488	98273.017	43	6.557	42	1.684	83300.745	643000	83300.745
Vanadium	MCP	8.877	9.733	43	6.557	42	1.684	11.376	51.6	11.376
Zinc	MCP	20.993	19.762	43	6.557	42	1.684	26.068	107	26.068

All values reported in ug/l(ppb).

contamination, at the landfill from the upper aquifer to the bedrock aquifer; 2) horizontal transport in the bedrock aquifer to the receptor (PW-1), and 3) vertical flow upward from the bedrock aquifer to the overburden withdrawal well induced by pumping. The vertical contaminant flow at the landfill from the overburden to the bedrock aquifer was determined by a one-dimensional steady-state analytical model assuming a uniform distributed source and utilizing the vertical flow velocity derived from the calibrated MODFLOW groundwater flow model. Horizontal contaminant migration was modeled by utilizing the horizontal flow velocity determined from the calibrated MODFLOW model and a one-dimensional transient, convective-dispersive analytical equation. Vertical migration was calculated based on assumed withdrawal rates and from equations for non steady-state withdrawal from unconfined aquifers. The concentration of contaminants in groundwater at the receptor is based on the relative contribution of groundwater from the bedrock aquifer. A complete description of the groundwater flow and transport models is presented in Appendix P.3.

Results: Modeling results show that concentrations of contaminants transported from the landfill to the nearest receptor (PW-1) will be approximately 0.01 percent of the concentrations detected onsite at the landfill.

1.3 Exposure Concentrations for Volatile Chemicals Released During Showering

Purpose: Groundwater is currently being used by residents living near the Ramapo Landfill. Human exposure may result from ingestion of groundwater but also from inhalation of contaminants transferred from groundwater to air during showering. Consequently, a model has been developed to estimate the quantity of volatile chemicals transferred from groundwater to air during showering, and the subsequent exposure concentrations in the shower after these chemicals have been volatilized.

<u>Methodology</u>: The method used for determining exposure concentrations is based on the method described in <u>Human Exposure to Volatile Organic Compounds in Household Tap Water: Indoor Inhalation Pathway</u> by Thomas McKone. Exposure concentrations in the shower were determined by the following equation.

$$CS = \frac{W \times \phi \times Cw}{Vs \times CF}$$

Where:

CS = Chemical Concentration in Air During Shower (mg/m^3)

W = Water Used During Shower (l)

ϕ = Transfer Efficiency from Water to Air (unitless)

CW = Chemical Concentration in Water (mg/l)

Vs = Volume of Shower (l)

CF = Conversion Factor for Water ($1\ m^3/1000\ l$)

Values for W (300 liters) and Vs (2000 liters) are representative values specified in McKone. Transfer efficiencies are based on the transfer efficiency of radon which has been measured and are dependent on specific chemical parameters. These transfer efficiencies were calculated as follows:

$$\phi = \phi \frac{\left(\frac{2.5}{Dwr^{2/3}} + \frac{RI}{Dar^{2/3}\ Hr}\right)}{\left(\frac{2.5}{Dw^{2/3}} + \frac{RT}{Da^{2/3}H}\right)}$$

Where:

ϕ_R = Transfer Efficiency for Radon (unitless)

Dwr = Diffusion Coefficient in Water for Radon (m^2/s)

Dar = Diffusion Coefficient in Air for Radon (m^2/s)

Hr = Henry's Law Constant for Radon ($Torr\text{-}m^3/mol$)

Dw = Diffusion Coefficient for Chemical in Water (m^2/s)

Da = Diffusion Coefficient for Chemical in Air (m^2/s)

H = Henry's Law Constant for Chemical (Torr-m^3/mol)
R = Gas Constant, 0.0624 (Torr-m^3/mol-K)
T = Temperature (K)

Values for ϕ_R (0.70), Dwr (1.4 EE-09 m^2/s), Dar (2.0 EE-05 m^2/s), and Hr (70 Torr. m^3/mol) are as presented in McKone. Values for chemical specific parameters were obtained from the literature.

Results: Transfer efficiencies for VOCs detected in groundwater are presented in Table 4. The transfer efficiencies ranged from 0.25 (4-methyl-2-Pentanone) to 0.66 (carbon disulfide). Exposure concentrations in the shower were calculated for current land use and future land use. Exposure concentrations for current use are based on onsite groundwater concentrations that have been reduced to account for attenuation resulting from transport offsite to the nearest receptor (Appendix P.3). Exposure concentrations for future use are based solely on groundwater data from onsite monitoring wells. Exposure concentrations in the shower for both current and future land use are presented in Table 5.

Section 1.3 References:

Ehrenfeld, J.R. et al. Controlling Volatile Emissions at Hazardous Waste Sites, Noyes Publications, New Jersey, 1986.

Hine, J. and P.K. Mookerjee, The Intrinsic Hydrophilic Character of Organic Compounds. Correlations in Terms of Structural Contributions. Journal of Organic Chemistry, 40:292-298, 1975.

Lyman W.J., Reehl W.F. and Rosenblatt, D.H., Handbook of Chemical Property Estimation Methods. McGraw Hill, 1982.

McKone, T.E., Human Exposure to Volatile Organic Compounds in Household Tap Water: The Indoor Inhalation Pathway. Environmental Science Technology, Vol. 21, No. 12, 1987.

TABLE 4

TRANSFER EFFICIENCIES (PHI) FOR CHEMICALS VOLATILIZING FROM WATER DURING SHOWERING

CHEMICAL	DIFFUSION COEFFICIENT AIR (m^2/s)	DIFFUSION COEFFICIENT WATER (m^2/s)	HENRY'S LAW CONSTANT (torr*m^3/mol)	TRANSFER EFFICIENCY(PHI) (unitless)
Benzene	9.32E-06	1.03E-09	4.2	0.5683
Tetrachloroethene	7.20E-06	8.20E-10	22	0.4897
Trichloroethene	8.75E-06	1.03E-09	6.8	0.5691
1,4-Dichlorobenzene	6.90E-06	7.90E-10	2.19	0.4743
Isopropylbenzene	7.02E-06	7.55E-10	10.64	0.4631
Total Xylene	7.00E-06	7.80E-10	5.35	0.4725
Dichlorodifluoromethane	9.44E-06	1.13E-09	2090	0.6069
Acetone	1.09E-05	1.14E-09	0.016	0.3008
Toluene	8.49E-06	9.10E-10	5.05	0.5236
1,1-Dichloroethane	9.19E-06	1.25E-09	4.14	0.6461
1,2-Dichloroethane	8.88E-06	1.04E-09	0.74	0.5608
p-Isopropyltoluene	6.46E-06	6.59E-10	4.88	0.4222
cis-1,2-Dichloroethene	7.60E-06	8.68E-10	5.76	0.5075
1,2,4-Trimethylbenzene	6.83E-06	6.59E-10	4.28	0.4221
Carbon Disulfide	1.05E-05	1.28E-09	9.12	0.6582
Propylbenzene	6.83E-06	6.59E-10	7.45	0.4228
Chloromethane	1.09E-05	1.18E-09	289	0.6247
Chlorobenzene	7.47E-06	9.31E-10	3	0.5301
Styrene	7.10E-06	8.00E-10	2.5	0.4788
1,2-Dichlorobenzene	6.90E-06	7.90E-10	1216	0.4781
1,3,5-Trimethylbenzene	6.83E-06	6.59E-10	6.99	0.4227
4-Methyl-2-Pentanone	7.48E-06	7.18E-10	0.02	0.2521
tert-Butylbenzene	6.39E-06	6.11E-10	8.74	0.4021

VARIABLE	
DIFFUSIVITY OF RADON IN AIR(m^2/s)	2.00E-05
DIFFUSIVITY OF RADON IN WATER(m^2/s)	1.40E-09
HENRY'S LAW CONSTANT FOR RADON (torr*m^3/mol)	70
TRANSFER EFFICIENCY (PHI) FOR RADON (unitless)	0.7
IDEAL GAS CONSTANT (m^3*torr/mol*K)	0.062396
TEMPERATURE (K)	298

TABLE 5

EXPOSURE CONCENTRATION IN THE SHOWER

CHEMICAL	CURRENT USE			FUTURE USE	
	CHEMICAL CONCENTRATION IN WATER (mg/l)	TRANSFER EFFICIENCY (PHI) (UNITLESS)	CHEMICAL CONCENTRATION IN AIR (mg/m^3)	CHEMICAL CONCENTRATION IN WATER (mg/l)	CHEMICAL CONCENTRATION IN AIR (mg/m^3)
Benzene	1.54E-07	0.5683	1.31E-05	1.54E-03	1.31E-01
Tetrachloroethene	6.00E-08	0.4897	4.41E-06	6.00E-04	4.41E-02
Trichloroethene	2.00E-08	0.5691	1.71E-06	2.00E-04	1.71E-02
1,4-Dichlorobenzene	5.62E-08	0.4743	4.00E-06	5.62E-04	4.00E-02
Isopropylbenzene	8.50E-08	0.4631	5.91E-06	8.50E-04	5.91E-02
Total Xylene	1.57E-07	0.4725	1.12E-05	1.57E-03	1.12E-01
Dichlorodifluoromethane	2.00E-08	0.6069	1.82E-06	2.00E-04	1.82E-02
Acetone	6.68E-07	0.3008	3.02E-05	6.68E-03	3.02E-01
Toluene	1.00E-07	0.5236	7.85E-06	1.00E-03	7.85E-02
1,1-Dichloroethane	1.74E-07	0.6461	1.68E-05	1.74E-03	1.68E-01
1,2-Dichloroethane	2.00E-08	0.5608	1.68E-06	2.00E-04	1.68E-02
p-Isopropyltoluene	6.98E-08	0.4222	4.42E-06	6.98E-04	4.42E-02
cis-1,2-Dichloroethene	9.00E-08	0.5075	6.85E-06	9.00E-04	6.85E-02
1,2,4-Trimethylbenzene	6.08E-08	0.4221	3.85E-06	6.08E-04	3.85E-02
Carbon Disulfide	1.53E-07	0.6582	1.51E-05	1.53E-03	1.51E-01
Propylbenzene	5.29E-08	0.4228	3.35E-06	5.29E-04	3.35E-02
Chloromethane	2.72E-07	0.6247	2.55E-05	2.72E-03	2.55E-01
Chlorobenzene	2.33E-07	0.5301	1.86E-05	2.33E-03	1.86E-01
Styrene	6.00E-08	0.4788	4.31E-06	6.00E-04	4.31E-02
1,2-Dichlorobenzene	5.94E-08	0.4781	4.26E-06	5.94E-04	4.26E-02
1,3,5-Trimethylbenzene	8.81E-08	0.4227	5.59E-06	8.81E-04	5.59E-02
4-Methyl-2-Pentanone	3.00E-07	0.2521	1.13E-05	3.00E-03	1.13E-01
tert-Butylbenzene	6.01E-08	0.4021	3.62E-06	6.01E-04	3.62E-02

VARIABLE	ADULT	CHILD
VOLUME OF WATER USED IN SHOWER (Liters)	300	300
VOLUME OF SHOWER (m^3)	2	2

National Academy of Sciences, The Alkyl Benzenes. National Academy Press, Washington, D.C., 1980.

Perry, R.H. et al. Perry's Chemical Engineer's Handbook, 6th ed., McGraw Hill, 1984.

USEPA, Superfund Public Health Evaluation Manual, EPA 540/1-86/060, 1986.

USEPA, Superfund Exposure Assessment Manual, EPA 540/1-88/001, 1988.

1.4 Toxicity Profiles

Following are brief descriptions of all contaminants detected onsite with relevant information about toxicity and health effects. The characteristics of these chemicals are discussed in general terms, as are the potential toxic effects. Specific toxicological data is presented in Section 6.4 of the RI report. It should be noted that the following profiles discuss potential toxic effects of chemical in pure form, and do not imply that these effects will be experienced at the concentrations found at the Ramapo Landfill site.

ACENAPHTHENE

Acenaphthene, $C_{12}H_{10}$, is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. Acenaphthene is found in coal tar pitch used by industry as an adhesive. It is also used as a dye intermediate, insecticide and fungicide; and in the manufacture of some plastics. People may be exposed to acenaphthene from environmental sources such as air, water, and soil, and from cigarette smoke, gasoline exhaust condensates and overcooked food. Typical exposures are not usually to acenaphthene alone, but to a mixture of similar chemicals.

Classification

This substance/agent has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential.

Health Effects

Acenaphthene is a skin and mucous membrane irritant. If swallowed in large quantities it may cause vomiting.

ACETONE

Acetone, C_3H_6O, is a colorless liquid with a sweetish odor. It has a boiling point of 56.48°C and a density of 0.7972. It is used as a solvent for waxes, oils, resins, rubber, plastic, lacquers, varnishes, and rubber cement. It is used in the production of lubricating oils, pharmaceutical and pesticides.

Classification

This chemical is classed as a group D compound, not classifiable as to human carcinogenicity due to lack of data for humans and animals.

Health Effects

Acetone may irritate the eyes, skin, nose and throat. It's points of attack are the respiratory system and the skin. Inhalation may produce headache, fatigue, excitement, bronchial irritation, and in large amounts narcosis. Prolonged or repeated topical use may cause erythema and dryness.

ALUMINUM

Aluminum is a common element of the natural environment comprising up to 10 percent of the content of soil and stone. Aluminum is generally not toxic to animals. Solubility increases at low pH and in acidic waters, such as bogs, aluminum concentrations can reach levels toxic to fish.

Aluminum has many uses including: corrosion-resistant chemical equipment, uses in the electrical industry, photoengraving plates, in points and protective coatings, as a catalyst, as rocket fuel, and as an ingredient of incendiary mixtures.

Classification

The U.S. EPA classifies aluminum as a class E compound, a non-carcinogen.

Health Effects

Aluminum salts may cause dermatitis, eczema, conjunctivitis, and mucous membrane irritation. Inhalation of fine aluminum powder has been reported as a cause of pulmonary fibrosis. Aluminum may also be implicated in Alzheimer's disease (Sax).

ANTHRACENE

Anthracene, $C_6H_4(CH)_2C_6H_4$, is one of the polycyclic aromatic hydrocarbon (PAH) compounds. It is a yellow crystal with blue fluorescence, which is insoluble in water, soluble in alcohol and ether. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and soil and onto crops. Anthracene is found in coal tar pitch used by industry as an adhesive. It is used in dyes, calico printing, as a component of smoke screens and as scintillation counter crystals.

People may be exposed to anthracene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to anthracene alone, but to a mixture of similar chemicals.

Classification

USEPA weight-of-evidence classification--D, not classifiable as to human carcinogenicity on the basis that no human data and inadequate data from animal bioassays exists.

Health Effects

Anthracene is a skin irritant and an allergen. It is an experimental equivocal tumorigenic agent and has experimental neoplastic effects.

ARSENIC

Arsenic, As, is present as an impurity in many metal ores and is produced as a by-product in the smelting of these ores, particularly copper. It is labelled as a poison and is used in a variety of industries: agricultural, insecticides, herbicides, pharmaceuticals, pigment production, and manufacturing of glass.

Classification

This substance and certain arsenic compounds have been listed as carcinogens. The weight of evidence classification as to human carcinogenicity is listed in Group A based on observation of increased lung cancer mortality in populations exposed primarily through inhalation and an increased skin cancer incidence in several populations consuming drinking water with high arsenic concentrations.

Health Effects

Arsenic can be inhaled or ingested through dust and fumes. Acute toxic effects are generally seen following ingestion of the compound. Symptoms may develop within one-half to four hours following ingestion and are characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. If large amounts are ingested, shock may develop due to severe fluid loss, and death may ensue within 24 hours. Exfoliative dermatitis and peripheral neuritis may develop. Acute cases due to inhalation are rare. Chronic arsenic poisoning due to ingestion is also rare. It can, however, be inhaled resulting in symptoms of weight loss, nausea, eruption of the skin, loss of hair, and peripheral neuritis. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenic poisoning. Liver damage from chronic poisoning is still debated. Arsenic does have a depressant effect upon bone marrow, with evidence of also causing lung and skin cancer.

BARIUM

Barium, Ba, an alkaline earth metal, is a silver-white, slightly lustrous, somewhat malleable metal. It is produced by the reduction of barium oxide. The primary sources are the minerals barite ($BaSo_4$) and witherite ($BaSo_3$). Barium may ignite spontaneously in air in the presence of moisture involving hydrogen. Most barium compounds are soluble in water, although the chemical itself is not. Metallic barium is used as a carrier for radium and for the removal of residual gas in vacuum tubes and in alloys with nickel, lead, calcium, magnesium, sodium, and lithium. Barium compounds are used in several manufacturing operations: X-ray diagnostic work, glassmaking, papermaking, and animal and vegetable oil refining. They are used in brick and tile, pyrotechnics, and the electronics industries. They are found in lubricants, pesticides, glazes, textiles dyes and finishes, pharmaceuticals, rodenticides, a stabilizer and mold lubricant in the rubber plastics industries, an extender in paints, a loader for paper, soap, rubber and linoleum, and a fire extinguisher for uranium or plutonium fires.

Classification

This chemical has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential.

Health Effects

The soluble barium salts, such as chloride and sulfide, are poisonous when ingested (Sax/Lewis, 1987). The insoluble sulfate used in radiography is not acutely toxic. Few cases of systemic poisoning have been reported. Barium compounds, when ingested or given orally, exert a profound effect on all muscles and especially smooth muscles, markedly increasing their contractility. The heart rate is slowed and may stop in systole. Other effects are increased intestinal peristalsis, vascular constriction, bladder contraction, and increased voluntary muscle tension. The inhalation of barium sulfate dust may lead to deposition in the lungs in sufficient quantities to produce "baritosis", a benign pneumoconiosis. Barium and its compounds may affect the heart, lungs, central nervous system, skin, eyes, and respiratory system (Sittig, 1985).

BENZENE

The hydrocarbon benzene, C_6H_6, is a clear, volatile colorless liquid with a characteristic odor. Uses of benzene include: a constituent in motor fuels, as a solvent, imprinting, as a chemical intermediate, and in the manufacture of detergents, explosives, pharmaceuticals and dye stuffs.

Classification

Benzene is recognized as a human carcinogen (IARC, 1982; IRIS, 1991). A weight of evidence of A, positive human carcinogen has been established based on studies of increased incidence of nonlymphocytic leukemia from occupational exposure and increased incidence of neoplasia in rats and mice exposed by inhalation and gavage (IRIS, 1991).

Health Effects

Poisoning occurs most commonly via inhalation of the vapor, though benzene can be ingested and penetrate the skin and poison in that manner. Exposure to benzene can cause irritation to the skin, eyes, and upper respiratory tract; erythema, vesiculation, and dry, scaly dermatitis can result from defatting of the skin; pulmonary edema and hemorrhage can result if the liquid gets taken into the lung. Acute benzene exposure will cause central nervous system depression, headache, dizziness, nausea, convulsions and possibly even coma and death.

Benzene is a recognized leukemogen. In several studies occupational exposure has been shown to be the cause of increased incidences of nonlymphocytic leukemia. Benzene is a myelotoxic agent therefore, chronic benzene exposure may result in hypo or hyperplasia of the bone marrow, which will in turn cause changes in the peripheral blood. Anemia, leucopenia, macrocytosis, reticulocytosis, thrombocytopenia, and prolonged bleeding time may result. Other effects of chronic benzene exposure are: fatigue, headache, dizziness, nausea, loss of appetite, weight loss, weakness, pallor, nosebleeds, bleeding gums, menorrhagia, petechiae and purpura. Chronic benzene poisoning exhibits great variation in symptoms between individuals.

ALPHA-AND DELTA-BENZENE HEXACHLORIDE (BHC)

Alpha-and delta-BHC, $C_6H_6Cl_6$, are isomers of 1,2,3,4,5,6-hexachlorocyclohexane, a white or yellowish powder or flake with a musty odor. [The color, odor, and melting point of the compound vary with the isomeric composition.] BHC is insoluble in water, but soluble in 100 percent alcohol, chloroform, and ether. It is used as an insecticide.

Classification

Delta-BHC is not yet classified. The alpha isomer has a weight of evidence classification of B2, a probable human carcinogen. This is based upon evidence of liver tumors in mice. Human carcinogenicity data inadequate.

Health Effects

Highly toxic by ingestion, moderately by inhalation. Absorbed by skin. Strong irritant to skin and eyes. Central nervous system depressant. When heated to decomposition, it emits toxic chloride fumes.

GAMMA-BENZENE HEXACHLORIDE (BHC)

Gamma-BHC (lindane), $C_6H_6Cl_6$, is an isomer of 1, 2, 3, 4, 5, 6-hexachlorocyclohexane. It is the most insecticidally active of this compound's 8 stereoisomers and because of this the most economically important. It is a white or yellowish powder or flake with a musty odor. [Color, odor, and melting point vary with isomeric composition.] It is insoluble in water, but soluble in 100 percent alcohol, chloroform, and ether. It has been used against insects in a wide range of applications.

Classification

Lindane has a weight-of-evidence classification of B2-C a possible-to-probable human carcinogen. This is based upon evidence of liver tumors in mice. Human carcinogenicity data are inadequate.

Health Effects

Irritation of eyes, nose, and throat, headaches, respiratory problems, muscular spasms.

BENZO(A)ANTHRACENE

Benzo[a]anthracene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Benzo[a]anthracene is found in coal tar pitch used by industry as an adhesive.

People may be exposed to benzo[a]anthracene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to benzo[a]anthracene alone, but to a mixture of similar chemicals.

Classification

The weight-of-evidence classification for benzo[a]anthracene is B2--probable human carcinogen based on no human data and sufficient data from animal bioassays.

Health Effects

Benzo[a]anthracene produced tumors in mice exposed by gavage, intraperitoneal, subcutaneous or intramuscular injection, and topical application. Benzo[a]anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture.

Although there are no human data that specifically link exposure to benzo[a]anthracene to human cancers, benzo[a]anthracene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke.

BENZO(B)FLUORANTHENE

Benzo(b)fluoranthene (B(b)F), in its pure form, is a colorless crystalline solid at room temperature and has a molecular weight of 252.32 g/mole. It has a vapor pressure of 5×10^{-7} and an octanol water coefficient of $1/15 \times 10^{6}$, and is therefore expected to have poor mobility in the environment. B(b)F is a polycyclic aromatic hydrocarbon that is formed during combustion of fossil fuels and organic material. It is found environmentally in mixtures with other PAH compounds including B(a)P.

Classification

The USEPA weight of evidence classification for B(b)F is B2- probable human carcinogen. Sufficient evidence of carcinogenicity in animals exists, in the absence of positive human data.

Health Effects

There are no data available to assess significant exposure levels of B(b)F alone for humans. Reports of adverse health effects such as carcinogenicity by the inhalation and dermal routes of exposure do exist for mixtures that include B(b)F thus providing some information to qualitatively assess the role of B(b)F as a human carcinogen.

No information has been found about specific levels of B(b)F that have caused harmful effects in humans after ingestion, inhalation, or dermal contact. The carcinogenicity of B(b)F has not been adequately studied, there are no reports directly correlating human B(b)F exposure and tumor development, although humans are likely to be exposed by all routes. There are a number of reports associating human cancer with exposure to mixtures of PAHs that include B(b)F. B(b)F is a skin carcinogen in animals following dermal application, and a lung carcinogen following intratracheal instillation. It is likely that B(b)F could cause cancer in humans as well.

BENZO(K)FLUORANTHENE

Benzo[k]fluoranthene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Benzo[k]fluoranthene is found in coal tar pitch used by industry as an adhesive.

People may be exposed to benzo[k]fluoranthene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to benzo[k]fluoranthene alone, but to a mixture of similar chemicals.

Classification

The USEPA weight-of-evidence classification for benzo[k]fluoranthene is B2, a probable human carcinogen on the basis that no human data and sufficient data from animal bioassays exists.

Health Effects

Benzo[k]fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice.

Benzo[k]fluoranthene is mutagenic in bacteria. Although there are no human data that specifically link exposure to benzo[k]fluoranthene to human cancers, benzo[k]fluoranthene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke.

BENZO(G,H,I)PERYLENE

Benzo[g,h,i]perylene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Benzo[g,h,i]perylene is found in coal tar pitch used by industry as an adhesive.

People may be exposed to benzo[g,h,i]perylene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to benzo[g,h,i]perylene alone, but to a mixture of similar chemicals.

Classification

USEPA weight-of-evidence classification-- D; not classifiable as to human carcinogenicity based upon no human data and inadequate animal data from lung implant, skin-painting and subcutaneous injection bioassays.

Health Effects

Benzo[g,h,i]perylene appeared to increase lung epidermoid tumors when administered with trioctanonin in a lung implant study. In a lifetime implant study, 3-month-old female Osborne-Mendel rats received a lung implant of benzo[g,h,i]perylene. Epidermoid carcinomas in the lung and thorax were observed. The apparent increased incidence of tumors was not statistically significant and no distant tumors were seen.

BENZO(A)PRYRENE

Benzo(a)pyrene (B(a)P), $C_{20}H_{12}$, is a polycyclic aromatic hydrocarbon (PAH) compound. It is formed when any organic material burns and is usually found in smoke and soot as a combustion by-product. B(a)P is found in coal tar pitch used by industry, and is found in creosote.

Classification

B(a)P weight of evidence is B2 because of sufficient evidence of carcinogenicity in experimental animals, but inadequate evidence of cancer in humans from epidemiologic studies.

Health Effects

Short term and intermediate oral exposure to very high levels of B(a)P resulted in death in experimental animals fed B(a)P in the diet. The induction of cancer is the key endpoint of toxicity following chronic exposures to lower doses of B(a)P in the diet. Lethal effects from high doses of B(a)P were caused by bone marrow depression. There is no information available for the potential of human carcinogenicity following oral B(a)P exposure. Studies with experimental animals have produced leukemia and tumors of the forestomach and lung following intermediate exposures in mice.

No short term or intermediate inhalation exposure effects are available for B(a)P. The induction of cancer is the key long term effect. B(a)P is a moderately potent experimental carcinogen in many species by many routes of exposure. There are no reports directly correlating human B(a)P exposure and tumor development, although humans are likely to be exposed by all routes. There are a number of reports associating human cancer and exposure to mixtures of PAHs that include B(a)P. In view of these observations and it's well established carcinogenic activity in laboratory animals, it is reasonable to conclude that B(a)P would be expected to be carcinogenic to humans by all routes of exposure.

BERYLLIUM

Beryllium, Be, is a gray metal that combines the properties of light weight and high tensile strength. Beryllium is used as a neutron reflector and neutron moderator in nuclear reactors. It is also used in the manufacture of beryllium alloys, namely beryllium copper and beryllium aluminum. Beryllium is also used for radio components, in aerospace structures, and inertial guidance systems.

Classification

The U.S. EPA's weight of evidence classification for human carcinogenicity is Group B2: a probable human carcinogen based on limited evidence from studies in humans and sufficient studies in animals. Beryllium has been shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. Human epidemiology studies are considered to be inadequate (IRIS, 1989).

Health Effects

Death may result from short exposure to very low concentrations of the element and its salts (Merck, 1983). Contact dermatitis, chemical conjunctivitis, corneal burns, nonhealing ulceration at site of injury, and subcutaneous nodules may occur following exposure. Acute effects include pneumonitis, which may result from single exposure to beryllium and occasionally is fatal. Pulmonary granulomatens disease may appear in three months to 15 years often after short exposure. The death rate is approximately 25 percent.

Studies of workers at a beryllium processing plant reported significant increases of lung cancer. There is evidence for induction of tumors by a variety of beryllium compounds via inhalation and intratracheal instillation and the induction of osteosarcomas in rabbits by intravenous or intramedullary injection in multiple studies (IRIS, 1989).

2-BUTANONE

2-Butanone, C_4H_8O, otherwise known as methyl ethyl ketone (MEK), is a colorless liquid with a fragrant, mintlike moderately sharp odor. It is used as a solvent in coating industries, in the manufacturing of synthetic resins, in cements and adhesives, and in the dewaxing of lubricating oils.

Classification

The weight of evidence classification by the U.S. EPA categorizes MEK in Group D, which does not list MEK as a human carcinogen. No data presently exist to evaluate this classification, evidence for carcinogenicity in humans and animals is inadequate.

Health Effects

MEK may affect the central nervous system and the lungs. It may be inhaled, absorbed through the skin, ingested, or contact the eyes and skin. Headaches, dizziness, or vomiting may develop. It is moderately toxic by ingestion. MEK irritates the eyes at concentration in the range of 350 ppm. No other adverse effects have been observed.

TERT-BUTYLBENZENE

Tert-butylbenzene (2-methyl-2-phenylpropane), $C_6H_5C(CH_3)_3$, is a colorless, combustible liquid, insoluble in water but soluble in alcohol. It is used as a polymerization solvent and as a polymer linking agent.

Classification

Not yet classified.

Health Effects

Tert-butylbenzene is moderately toxic by ingestion.

BUTYLBENZYLPHTHALATE

Butylbenzylphthalate, $C_4H_9OOCC_6H_4OOC_7H_7$, is a clear, oily liquid with a slight odor. It is also known as benzylbutylphthalate on BBP. It has a melting point of less than -35°C, boiling point of 370°C and density of 1.116. Butylbenzylphthalate is used as a plasticizer for polyvinyl and cellulosic resins and as an organic intermediate.

Classification

Butylbenzylphthalate has a weight of evidence of C. It is considered a possible human carcinogen based on a significant increase in mononuclear cell leukemia in female rats. There is no data on human carcinogenity.

Health Effects

Oral administration of butylbenzylphthalate to rats resulted in decreased body weight gain, small testes, testicular lesions, and decreased hemoglobin, hematocrit and red blood cell count. Liver and kidney effects were also reported. No information on human health effects was found.

CADMIUM

Cadmium, Cd, is a metallic element. It is naturally occurring in zinc, copper and lead ores. Since cadmium is very corrosion resistant it is used as protective coating for iron, steel and copper. Cadmium is used in alkaline batteries, as a stabilizer for polyvinyl chloride plastics, in nickel plating, and in the manufacture of semiconductors, photocells, and jewelry. Cadmium compounds are used as pesticides, polymerization catalysts, pigments, paints and in the photographic industry.

Classification

The USEPA classifies cadmium as having a weight of evidence of B1, being a probable carcinogen. Cadmium is also a teratogen and an experimental carcinogen.

Health Effects

The substance may attack the respiratory system, lungs, kidney, prostate, and blood. Cadmium compounds are well absorbed by inhalation but poorly absorbed from the intestinal tract. Skin absorption appears negligible. After being absorbed cadmium has a very long half life. It is stored in the kidneys and liver.

Acute health effects are usually delayed a few hours after exposure. There is irritation of the upper respiratory tract; possibly followed by coughing, chest pain, sweating and chills. 8 to 24 hours after exposure severe pulmonary irritation may develop with shortness of breath and general weakness. Breath may become shorter as pulmonary edema develops.

There is an approximately 15% mortality rate in acute cases. Survivors may have emphysema and corpulmonale.

The chronic effects of cadmium poisoning are kidney damage and mild hypochronic anemia. In experimental animals chronic effects have included liver damage, central nervous system damage, testicular atrophy, teratogenic effects (rodents), decrease in red blood cell count, sarcomata, and testicular neoplasms.

CALCIUM

Calcium is a common element of the natural environment. It is an alkaline earth metal which accounts for about 3.6% of the earth's crust (fifth element in order of abundance). The principal commercial source of calcium is limestone.

Calcium is used in metallurgy as a deoxidizer for copper, beryllium and steel. It is also used to harden lead for bearings, to manufacturer flints, and in the manufacture of electric vacuum tubes.

Classification

Calcium is not classified by the USEPA for human carcinogenicity.

Health Effects

Calcium is an essential constituent of bones and teeth. Calcium metal may ignite in air if finely divided.

CARBON DISULFIDE

Carbon disulfide, CS_2, is a mobile, clear, or faintly yellow liquid. Pure distillates have a sweet pleasing ethereal odor. Reagent and commercial grades are foul-smelling. It is used in the manufacture of soil disinfectants, vacuum tubes, and for cleaning and extractions, especially in metal treatment and plating. It is a fumigant for commodities, a corrosion inhibitor, and a polymerization inhibitor for vinyl chlorides.

Classification

This chemical has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential. No weight of evidence is classified.

Health Effects

Poisoning usually occurs from inhalation but also may be caused by ingestion and skin absorption. Acute toxicity exhibits euphoria, restlessness, mucous membrane irritations, nausea, vomiting, unconsciousness, and terminal convulsions. Chronic toxicity exhibits marked psychic disturbances ranging from extreme irritability to mania with hallucinations, tremors, auditory and visual disturbances, weight loss, and blood dyscrasia. Dermal contact with concentrated solutions may cause burning, pain, erythema, and exfoliation.

CARBON TETRACHLORIDE

Carbon tetrachloride, CCl_4, is a colorless non-flammable liquid with a characteristic odor. It is also known as tetrachloromethane and perchloromethane. Carbon tetrachloride is used as a solvent for oils, fats, lacquers, varnishes, rubber, waxes and resins. It is used in the synthesis of fluorocarbons, as a dry cleaning agent, a fire extinguishing agent, and as a fumigant.

Classification

Carbon tetrachloride is classified as a group B2 chemical, a probable human carcinogen.

Health Effects

Carbon tetrachloride removes the natural lipid cover of the skin. Repeated contact may cause a dry, scaly, fissued dermatitis. Eye contact is slightly irritating. Signs and symptoms of liver and kidney damage may develop after acute exposure. Nausea, vomiting, abdominal pain, diarrhea, enlarged and tender liver, and jaundice result from toxic hepatitis. Diminished urinary volume, red and white blood cells in the urine, albuminuria, coma and death may be consequences of acute renal failure. Excessive exposure may result in central nervous system depression and gastrointestinal symptoms.

Carbon tetrachloride produces liver tumors in rats and mice after administration by various routes. Oral administration has caused liver tumors in trout and hamsters.

ALPHA AND GAMMA-CHLORDANE

Alpha-and gamma-chlordane, C_{10} H_6 Cl_8, are isomers of 1,2,4,5,6,7,8,8-octochloro-4,7-methano-3a,4,7,7a-tetrahydroindane. Chlordane is a pale yellow, odorless, viscous (non-volatile) liquid that is soluble in many organic solvents but insoluble in water. It is miscible in deodorized kerosene, and decomposes in weak alkalies. It has been used as a broad-spectrum insecticide, but is currently used mainly for termite control.

Classification

Chlordane has a weight-of-evidence classification of B2, a probable human carcinogen. This is based on incidence of liver tumors in mice. Human carcinogenicity data are inadequate.

Health Effects

Chlordane isomers are an oral, intravenous, inhalation, and intrapritoneal poisons. Chlordane is also absorbed by the skin. It is implicated in aplastic anemia, and is a central nervous system stimulant, causing loss of appetite and neurological symptoms. On heat decomposition it emits highly toxic chloride fumes.

Signs and symptoms of exposure include increased sensitivity to stimuli, tremors, muscular incoordination, and convulsions with or without a coma. There are some reports of delayed development of liver disease, blood disorders, and upset stomach. Chlordane is considered to be moderately to highly toxic.

CHLOROBENZENE

Chlorobenzene, C_6H_5Cl, otherwise known as benzene chloride, is a clear, colorless liquid used in the manufacture of aniline, phenols, and as an intermediate of dyes and pesticides.

Classification

The weight of evidence for carcinogenicity by the U.S. EPA is presently being evaluated. This does not imply that chlorobenzene is necessarily a carcinogen.

Health Effects

Chlorobenzene can be inhaled, ingested, or irritate the eyes and skin. It may affect the respiratory and central nervous systems, and the liver. It may cause drowsiness, incoherence, skin irritation, and liver damage. Little is known of the effects of repeated exposures at lower concentrations, but it may also cause kidney damage. Histopathologic changes have been observed in the liver in animal studies (Monsanto, 1967).

CHLOROMETHANE

Chloromethane (methyl chloride), CH_3 Cl, is a colorless, liquidified, flammable gas with a faint, sweet odor. It is slightly soluble in water, by which it is decomposed. It is soluble in alcohol, chloroform, benzene, carbon tetrachloride, and glacial acetic acid. It attacks active metals such as aluminum, magnesium, and zinc. Chloromethane is used as a methylating and chlorinating agent, and as an extractant for greases, oils, and resins. It is also used as a solvent in the synthetic rubber industry, as a refrigerant, and sometimes as a propellant. In the past it has been used as a local anaesthetic. It is an intermediate in drug manufacture.

Classification

Chloromethane has a weight-of-evidence classification of C, a possible human carcinogen. This is based upon incidence of kidney tumors in mice. Human carcinogenicity data are inadequate.

Health Effects

Points of attack are the liver, kidneys, skin, and central nervous system. Acute exposure predominantly depresses the central nervous system (causing psychiatric disturbances), but renal and hepatic damage may also occur. Bone marrow activity is depressed. Several hours after exposure such symptoms as staggering gait, nausea, and dizziness may be observed. Dangerous fire hazard. Heat decomposition causes very toxic chloride fumes to be emitted.

CHROMIUM

Chromium is a naturally occurring element that is found in soil and in volcanic dusts and gasses. It is found in the environment in three major states, chromium (0), chromium (III), and chromium (VI). Chromium (III) occurs naturally in the environment, while chromium (0) and chromium (VI) are generally produced by industrial processes. Chromium (0) is the metallic form and is used in steel making and for electroplating. Other chromium compounds are made by the chemical industry for use as pigments, and in leather tanning, rubber making, wood treatment, and water treatment.

Classification

The USEPA weight-of-evidence classification for hexavalent chromium is A, a human carcinogen by the inhalation route. Results of epidemiologic studies are consistent across investigators and locations. Dose-response relationships for lung tumors have been established. Evidence for other chromium compounds (trivalent and metallic) is inconclusive.

Health Effects

The three forms of chromium have different effects on health. Hexavalent chromium is irritating. Acute effects may include: ulcers of the skin, irritation of the nasal mucosa, perforation of the septum and gastrointestinal irritation. Kidney and liver damage, and inflammation and ulceration of the gastrointestinal tract are also possible, as are chronic effects.

Trivalent chromium is an essential nutrient. The minimum daily requirement for optional health is not known, but it is estimated that a daily ingestion of 50-200 micrograms/day is safe and adequate. Chromium (III) may be harmful at very high doses.

The health effects of metallic chromium (chromium (0)) are not well characterized.

Epidemiologic studies of chromate production facilities in the United States, Great Britain, Japan, and West Germany have established an association between chromium exposure and lung cancer. Most of these studies did not attempt to determine whether Cr III or Cr VI compounds were the etiologic agents. Three studies of the chrome pigment industry, one in Norway, one in England, and the third in the Netherlands and Germany also found an association between occupational chromium exposure (predominantly to Cr VI) and lung cancer. Hexavalent chromium compounds were carcinogenic in animal assays producing the following tumor types: intramuscular injection site tumors, intraplural implant site tumors for various chromium VI compounds, intrabronchial implantation site tumors for various Cr VI compounds, and subcutaneous injection site sarcomas.

CHRYSENE

Chrysene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Chrysene is found in coal tar pitch used by industry as an adhesive.

People may be exposed to chrysene from environmental sources such as air, water, and from tobacco smoke and overcooked food. Typical exposures are not usually to chrysene alone, but to mixtures of similar compounds.

Classification

The USEPA weight-of-evidence classification for chrysene is B2, a probable human carcinogen on the basis that no human data and sufficient data from animal bioassays exists.

Health Effects

Chrysene produced carcinomas and malignant lymphoma in mice after intraperitoneal injection and skin carcinomas in mice following dermal exposure. In mouse skin painting assays chrysene tested positive in both initiation and complete carcinogen studies. Chrysene produced chromosomal abnormalities in hamsters and mouse germ cells after gavage exposure, positive responses in bacterial gene mutation assays and transformed mammalian cells exposed in culture. It was shown to be a complete carcinogen. Chrysene has produced positive results for initiating activity in several mouse strains when applied in combination with various promoting agents producing skin papillomas and carcinomas.

Although there are no human data that specifically link exposure t chrysene to human cancers, chrysene is a component of mixtures that hav been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke.

COBALT

Cobalt is a metallic element that occurs naturally in various valences (+1, +2, +3 rarely +4, +5) and one isotope ^{59} Co. Cobalt appears to be essential to life with pernicious anemia developing in it's absence.

Classification

Not classified for carcinogenicity by the U.S. EPA.

Health Effects

Naturally occurring cobalt is essential to plant and animal life. There are numerous man-made cobalt compounds that are toxic in varying degrees.

Ingestion of soluble cobalt salts produces nausea and vomiting by local irritation. Inhalation of metallic dust may cause pulmonary symptoms. Powder may cause dermatitis (Merck, 1989)

COPPER

Cooper is a reddish-brown metal which occurs in the earth's crust at a concentration of 70 ppm. Copper is also present in seawater.

The uses of copper include: the manufacture of bronzes, brass, other copper alloys, electrical conductors, ammunition, copper salts, insecticides, fungicides, pigments, catalysts, analytical reagents, electroplating and paints.

Classification

The USEPA weight of evidence for copper is D, not classifiable as to human carcinogenicity on the basis of inadequate evidence in humans and animals.

Health Effects

The local effects of copper salts are irritant effects: itching and erythema. Conjunctivitis and even ulceration and turbidity of the corneas may be caused by contact of copper salts with the eyes.

The fumes and dust generated by welding copper-containing metals may cause upper respiratory irritation, a metallic taste in the mouth, nausea, metal fume fever and possibly discoloration of the hair and skin. Inhalation of dusts, fumes and mists of copper salts may result in the congestion of nasal mucous membranes, sometimes of the pharnyx and on occasion, ulceration with perforation of the nasal septum. In the GI tract copper salts act as irritants producing salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis and diarrhea.

"Chronic human intoxication occurs rarely and then only in individuals with Wilson's disease. This is a genetic condition caused by the pairing of abnormal autosomal recessive genes in which there is abnormally high absorption, retention, and storage of copper by the body. The disease is progressive and lethal if untreated." (Sitting, 1985).

CUMENE

Cumene (isopropylbenzene), $C_6H_5CH(CH_3)_2$, is a colorless, combustible liquid with a sharp, penetrating odor. It is soluble in alcohol, carbon tetrachloride, ether, and benzene, but insoluble in water. It is used as a high-octane gasoline component, and as a thinner for paints and lacquers. It is an important intermediate in the manufacture of phenol.

Classification

Not yet classified.

Health Effects

Exposure to cumene can cause irritation of the eyes and mucous membranes, headaches, dermatitis, narcosis, and coma. It is a central nervous system depressant and may be cumulative in its action. Cumene is more toxic than benzene or toluene. It is a potent human irritant via the inhalation route, but only a moderate irritant via the oral route.

CYMENE

Cymene (isopropyltoluene), $CH_3C_6H_4CH(CH_3)_2$, is a colorless, combustible liquid with an aromatic odor. Ortho-,meta-, and para- isomers are known. It is soluble in alcohol, ether, and chloroform, but insoluble in water. Cymene is used in the manufacture of synthetic resins, in metal polishes, and in organic synthesis.

Classification

Not yet classified.

Health Effects

Some human central nervous system effects are known at low dose rates. Low toxicity via oral and inhalation routes.

DIBENZOFURAN

Dibenzofuran is formed as a by-product in the manufacture of chlorinated herbicides, and is produced during the combustion of PCBs. It is not found in a pure form, but as a component of mixtures of dioxins and furans produced in a similar fashion.

Classification

The USEPA weight-of-evidence classification of dibenzofuran is D, not classifiable as to human carcinogenicity based upon no human data and no animal data for dibenzofuran alone.

Health Effects

There is no data on the possible carcinogenicity of dibenzofuran alone in humans. Studies have evaluated exposure to a mixture of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs) and polychlorinated quinones (PCQs) by consumption of contaminated rice oil. However, these studies have limited value because they do not assess dibenzofuran or correlate exposure with cancer risk. Additionally, because of the multiple exposures, the extent to which the various components contributed to the increase in cancer mortality cannot be determined.

No animal carcinogenicity data on dibenzofuran is currently available. The U.S. EPA (1986) noted that the biological activity of PCDFs varies greatly, so that risk assessment of dibenzofuran by analogy to any of these more widely studied compounds would not be recommended.

1,2 DICHLOROBENZENE

1,2-Dichlorobenzene, $C_6H_4Cl_2$, also known as 1,2-DCB, is a colorless to pale yellow liquid that is used as a process solvent in the manufacturing of toluene diisocyanate and as an intermediate in the synthesis of dye stuffs, herbicides, and degreasers.

Classification

This chemical is among those substances being evaluated by the USEPA for evidence of human carcinogenic potential. This does not imply that this chemical is necessarily a carcinogen.

Health Effects

Human exposure to 1,2-DCB is reported to cause hemolytic anemia and liver necrosis. Dichlorobenzenes in general are toxic to non-human mammals, birds, and aquatic organisms and impart an offensive taste and odor to water (Sittig, 1985). Persons with pre-existing pathology (hepatic, renal, and central nervous system) or metabolic disorders and are who taking certain drugs (hormones or other metabolically active), might be considered risks from exposure to 1,2-DCB. Irritation of eyes and nose, liver and kidney damage, and skin blisters may appear upon 1,2-DCB exposure.

1,4-DICHLOROBENZENE

In pure form, 1,4-dichlorobenzene is a white crystalline material that is volatile at room temperatures with a characteristic penetrating odor. It is used as an insecticidal fumigant, popular for protecting clothes against moths.

Classification

Not classified for carcinogenicity by USEPA.

Health Effects

Vapors may cause irritation to skin, throat, and eyes. Prolonged exposure to high concentrations may cause weakness, dizziness, and loss of weight. Liver injury may develop. (MERCK, 1989)

DICHLORODIFLUOROMETHANE

Dichlorodifluoromethane (Freon F-12), CCl_2F_2, is a colorless, virtually odorless, noncorrosive gas, soluble in water and in most organic solvents. It is nonflammable. It is used as a refrigerant and aerosol propellant, among other things.

Classification

Not yet classified.

Health Effects

A human eye and CNS irritant, narcotic in high concentrations. Heat decomposition emits highly toxic fumes of phosgene and fluorides.

1,1-DICHLOROETHANE

1,1-Dichloroethane, CH_3CHCl_2, is also known as ethylidene dichloride and ethylidene chloride. It is a colorless , neutral, flammable liquid with an aromatic odor and saccharin taste. 1,1-Dichloroethane is used as a chemical intermediate, has limited use as a solvent, and was formerly used as an anesthetic.

Classification

1,1-Dichloroethane has a weight of evidence of C, it is a possible human carcinogen. This is based on no human data and limited evidence of carcinogenicity in rats and mice.

Health Effects

1,1-Dichloroethane causes central nervous system depression, skin irritation, drowsiness, unconsciousness and liver and kidney damage.

Female rats have shown an increased incidence of mammary gland adenocarcinomas and hemangiosarcomas. Mice have shown an increased incidence of hepatocellular carcinomas and benign uterine polyps.

CIS 1,2-DICHLOROETHENE

Cis 1,2-Dichloroethene (acetylene dichloride), $C_2H_2Cl_2$, is a colorless, flammable liquid with a pleasant odor. It exists in two isomers: 60 percent cis and 40 percent trans. It is used as a general solvent for organic materials, especially for waxes, resins, and acetylcellulose. It is also used in the extraction of rubber, in pharmaceuticals manufacture, and in the extraction of oils and fat from fish and meat.

Classification

Not yet classified.

Health Effects

Systemic health effects include principally central nervous system depression.

Symptoms of acute exposure include dizziness, nausea, frequent vomiting and central nervous system intoxication similar to that caused by alcohol. Toxic by ingestion, inhalation, and skin contact.

1,2-DICHLOROETHANE

1,2-dichloroethane, $ClCH_2CH_2Cl$, is also known as ethylene dichloride. It is a colorless flammable liquid which has a pleasant odor and sweetish taste. 1,2-dichloroethane is used in the manufacture of ethylene glycol, diaminoethylene, polyvinyl chloride, nylon, rayon and various plastics. It is a solvent, a degreaser, and an extracting agent. It is also used as an antiknock agent in gasoline, a fumigant, in dry cleaning, in photography, xerography, water softening, and in the production of adhesives, cosmetics, pharmaceuticals and varnishes.

Classification

1,2-Dichloroethane has a weight of evidence of B2. It is a probable human carcinogen. There is no human data. Several tumor types were induced in rats and mice treated by gavage. Lung papillomas developed in mice after topical application.

Health Effects

Acute exposure to 1,2-dichloroethane may cause nausea, vomiting, eye damage, confusion, dizziness and pulmonary edema. Death has resulted from respiratory and circulatory failure. Chronic exposure can cause dry, scaly, fissured dermatitis; neurological changes; loss of appetite and other gastrointestinal problems; irritation of the mucous membranes; and liver and kidney damage.

DIELDRIN

Dieldrin, $C_{12}H_{10}Cl_6$, is the generic name for a cyclodiene insecticide containing 85 percent or more of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-dimethannaphthalene. It is a light-tan, flaked solid, insoluble in water, methanol, and aliphatic hydrocarbons. It is soluble in acetone and benzene. Dieldrin is used as an insecticide.

Dieldrin's environmental persistence is due to its extremely low volatility and low solubility in water. Due to its polarity, it has a high affinity for fats, resulting in progressive accumulation in the food chain.

Classification

Dieldrin has a weight-of-evidence classification of B2, a probable human carcinogen. This is based upon evidence of liver tumors in mice. Human carcinogenic data are inadequate.

Health Effects

Dieldrin is highly toxic by ingestion, inhalation, and skin absorption. It is a central nervous system stimulant. Nervous symptoms or anorexia may appear first, as well as headache, nausea, vomiting, convulsions, and coma. On heat decomposition very toxic chloride fumes are emitted.

DIETHYLPHTHALATE

Diethylphthalate, (DEP), $C_{12}H_{14}O_4$, is a clear, colorless liquid used as a solvent for cellulose esters; as a vehicle in pesticidal sprays; as a fixative and solvent in perfumery; as an alcohol denaturant; and as a plasticizer in solid rocket propellants.

Classification

The weight of evidence classification, categorized in Group D, does not classify DEP as a human carcinogen. No human carcinogenic data are available, and animal carcinogenic data is inadequate.

Health Effects

DEP can be poisonous by intravenous route (Sittig, 1985). It is also known to be an experimental teratogen and may be moderately toxic if ingested. It can be an eye irritant and a systemic irritant by inhalation. DEP is a narcotic in high concentrations (Sax, 1987).

DEP has few chronic toxic properties and seems to be devoid of any major irritating or sensitizing effects on the skin. Exposure to heated vapors may produce transient irritation of the nose and throat. Conjunctivitis, corneal necrosis, respiratory tract irritation, dizziness, nausea, and eczema are symptoms.

DI-N-OCTYLPHTHALATE

Di-n-octylphthalate, $C_6H_4(COOC_8H_{17})_2$, is a liquid which is also known as DOP. It is used as a plasticizer in the manufacture of plastics products.

Classification

Not classified for carcinogenicity by USEPA.

Health Effects

Di-n-octylphthalate is an eye and skin irritant. As a group, the phthalic acid esters are oily liquids used as intermediates in manufacturing or as lubricants. They are generally toxic in high concentrations and some are considered to be carcinogenic.

ETHYLBENZENE

Ethylbenzene, C_8H_{10}, is a colorless liquid with a pungent aromatic odor. It is used in the manufacture of cellulose acetate, styrene, and synthetic rubber.

Classification

The U.S. EPA weight of evidence classification is Group D: not classifiable as a human carcinogen based on the lack of animal bioassays and human studies.

Health Effects

Ethylbenzene is moderately toxic by irritation to skin, eyes, and mucous membranes, and by ingestion and inhalation routes (Sax/Lewis, 1987). The liquid is an irritant to the skin and mucous membranes. A concentration of 0.1 percent of vapor in the air is an irritant to human eyes, and a concentration of 0.2 percent is extremely irritating at first, then causes dizziness, irritation of the nose and throat, and a sense of constriction in the chest. Exposure to 1 percent concentration has been reported as causing anoxia, loss of consciousness, tremor of the extremities, and finally death through respiratory failure. Pathological findings were congestion of the brain and lungs, with edema. Ethylbenzene is an experimental teratogen.

BIS(2-ETHYLHEXYL)PHTHALATE

Bis(2-ethylhexy)phthalate, $C_6H_4(COOCH_2C_2H_5CH_2CH_2CH_2CH_3)_2$, is as colorless oily liquid with almost no odor. It is also known a BEHP. BEHP is produced by the reaction of 2-ethylhexyl alcohol and phthalic anhydride. It is used as a plasticizer for resin and in the manufacture of organic pump fluids.

Classification

The USEPA weight of evidence has classified BEHP in Group B2: a probable human carcinogen. This is based on studies where orally administered BEHP produced significant dose-related increases in liver tumor responses in rats and mice of both sexes.

Health Effects

BEHP can be inhaled, ingested, and be a skin and eye irritant. It may affect the upper respiratory and gastrointestinal systems. Symptoms may include irritation of the eyes and mucous membranes; nausea; and diarrhea (Sittig, 1985).

FLUORANTHENE

Fluoranthene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Fluoranthene is found in coal tar pitch used by industry as an adhesive.

People may be exposed to fluoranthene from environmental sources such as air, water, and from tobacco smoke and overcooked food. Typical exposures are not usually to fluoranthene alone, but to mixtures of similar compounds.

Classification

The USEPA weight-of-evidence classification for fluoranthene is D, not classifiable as to human carcinogenicity on the basis of no human data and inadequate data from animal bioassays.

Health Effects

Although fluoranthene has not exhibited the properties of a mutagen or primary carcinogen, there is concern about its toxicity. This concern is based on the fact that it is widespread in the environment and that it belongs to the PAH group which includes numerous potent carcinogens.

In a 13 week mouse oral subchronic toxicity study where mice were gauged with a range of doses of fluoranthene, all treated mice exhibited nephropathy, increased salivation, increased liver enzyme levels and increased liver weights in a dose-dependent manner. Microscopic liver lesions (indicated by pigmentation) were observed in 65 and 87.5% of the mid- and high-dose mice, respectively.

FLUORENE

Fluorene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when fossil fuels, garbage, or any other plant or animal material is burned, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Fluorene is found in coal tar pitch used by industry as an adhesive.

Although there is no human data that specifically links exposure to fluorene with human cancers, it is a component of mixtures that have been associated with human cancer. These include coal tar, soot, coke oven emissions, over-cooked food and tobacco smoke.

Classification

USEPA weight-of-evidence classification for fluorene is D, not classifiable as to human carcinogenicity based upon no human data and inadequate data from animal bioassays.

Health Effects

Mice were exposed to fluorene suspended in corn oil by gavage for 13 weeks. Increase salivation, hypoactivity, and urine-wet abdomens in males were observed in all treated animals. The percentage of mice exhibiting hypoactivity was dose-related. Labored respiration, ptosis (drooping eyelids), and unkempt appearance were also observed. A significant decrease in red blood cell count, packed cell volume, and hemoglobin concentration was observed. Increased total serum bilirubin levels were also observed. A dose-related increase in relative liver weight was observed in treated mice. A significant increase in absolute and relative spleen and kidney weight was observed in mice exposed to fluorene. Increases in the absolute and relative liver and spleen weights in high-dose males and females were accompanied by histopathological increases in the amounts of hemosiderin in the spleen and in the Kupffer cells of the liver. No other histopathological lesions were observed.

HEPTACHLOR EPOXIDE

Heptachlor epoxide, $C_{10}H_9Cl_7O$, is a degradation product of heptachlor, which is, in turn, a generic name for 1, 4, 5, 6, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindene. Heptachlor is a white to light-tan, waxy solid, insoluble in water, but soluble in xylene and alcohol. Heptachlor is used as an insecticide. Heptachlor epoxide also possesses insecticidal properties.

Classification

Heptachlor epoxide has a weight-of-evidence classification of B2, a probable human carcinogen. This is based upon evidence of liver tumors in mice. Human carcinogenic data are inadequate.

Health Effects

Heptachlor epoxide is more acutely toxic than heptachlor, which is itself highly toxic to aquatic life and persistent in the environment. Its chief points of attack are the central nervous system and liver. Routes of entry include inhalation, skin absorption, ingestion, and eye and skin contact.

Acute symptoms include tremors, convulsions, kidney damage, respiratory collapse, and death. Heat decomposition causes very toxic fumes of chloride to be emitted.

IRON

Iron has four naturally occurring valences (+2, +3, rarely +4, +6), and four stable isotopes. After oxygen, iron is the most commonly used element in manufacturing. Iron and its compounds have numerous uses.

Classification

Not classified for carcinogenicity by the USEPA.

Health Effects

Because of the large number of compounds, the range of toxicity by oral exposure is from non-toxic to highly toxic (MERCK, 1989). Iron is essential to most plant and animals in the naturally occurring valences

(+2, +3). Inhalation of dusts can cause irritation of mucous membranes.

LEAD

Lead (Pb) is a bluish-white, silvery-gray metal. It is used as a construction material for tank linings, piping, and other equipment handling corrosive gases and liquids used in the manufacture of sulfuric acid, petroleum refining, halogenation, sulfonation, extraction, condensation for x-ray and atomic radiation protection, manufacture of tetraethyllead, pigments for paint, organic and inorganic lead compounds, bearing metal and alloys; storage batteries; in ceramics, plastics, and electronic devices; in building construction; in solder; and other lead alloys (Merck, 1989).

Classification

The B2 U.S. EPA classification reflects a weight of evidence judgement of the likelihood that the agent is a human carcinogen based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is considered to be inadequate to refute or demonstrate potential carcinogenicity for humans from lead exposure (IRIS, 1989).

Health Effects

Lead poisoning is one of the commonest of occupational diseases. The presence of lead-bearing materials or lead compounds in an industrial plant does not necessarily result in exposure on the part of the worker. The lead must be in such form, and so distributed, as to gain entrance into the body or tissues of the worker in measurable quantity, otherwise no exposure can be said to exist. Some forms are experimental neoplastigens and tumorigens. The modes of entry into the body are by inhalation of dusts, fumes, mists or vapors; by ingestion of lead compounds trapped in the upper respiratory tract or introduced into the mouth on food, tobacco, fingers, or other objects; and through the skin. This route is of special importance in the case of organic compounds of lead, such as lead tetraethyl. In the case of inorganic forms of lead, this route is of no practical importance.

When lead is ingested, much of it passes through the body unabsorbed, and is eliminated in the feces. The greater portion of the lead that is absorbed is caught by the liver and excreted in part in the bile. For this reason, larger amounts of lead are necessary to cause poisoning if absorption is by this route, and a longer period of exposure is usually necessary to produce symptoms. Upon inhalation, absorption takes place easily from the respiratory tract and symptoms tend to develop more quickly. From the point of view of industrial poisoning, inhalation of lead is much more important than ingestion. Lead is a cumulative poison. Increasing amounts build up in the body and eventually a point is reached where symptoms and disability occur. Lead produces a brittleness of the red blood cells so that they hemolyze with slight trauma; the hemoglobin is not affected. Due to their increased fragility, the red blood cells are destroyed more rapidly in the body than normally, producing an anemia that is rarely severe. The loss of circulating red cells stimulates the production of new young cells, which on entering the blood stream, are acted upon by the circulating lead, with resultant coagulation of their basophilic material. Lead produces a damaging effect on the organs or tissues with which it comes into contact. Systemic effects include decreased physical fitness, fatigue, sleep, headache, aching bones and muscles, digestive symptoms, abdominal pains, and decreased appetite. Later findings include anemia, palloc, and "lead line" of the gums. Lead colic produces an intense periodic abdominal cramping associated with severe constipation, nausea, and vomiting. Alcohol ingestion and physical exertion may precipitate these symptoms. The peripheral nerve affected most frequently is the radial nerve. When the central nervous system is affected, it is usually due to the ingestion or inhalation of large amounts of lead. This results in severe headache, convulsions, coma, delirium, and possible death. The kidneys can also be damaged after long periods of exposure to lead with loss of kidney function and progressive azotemia.

MAGNESIUM

Magnesium is considered to be the lightest structural metal. It is found in nature in the +2 valence. It is essential to life, especially green plants. Magnesium is used as a constituent of light alloys; in the manufacture of precision instruments, optical mirrors, and pyrotechnics; in metallurgy; in dry batteries; for flash bulbs and flares; for Grignard reagents and in the recovery of titanium.

Classification

Magnesium is not classified by the USEPA for carcinogenicity.

Health Effects

Particles embedded in skin can produce gaseous blebs with a protracted course. Inhaling the dust is irritating, and fumes can cause metal fume fever.

MANGANESE

Manganese is a steel gray, lustrous, hard, brittle metal. It is a widely distributed element which constitutes 0.085% of the earths crust. It is primarily used in the manufacture of steel, for rock crushers, railway points and crossings, and as a constituent of several alloys.

Classification

The U.S. EPA weight of evidence classification is categorized as being in Group D: not classified as a human carcinogen based on limited evidence to evaluate carcinogenicity in humans and animals. No human carcinogenicity data exist.

Health Effects

Manganese compounds can cause central nervous system and pulmonary system damage by inhalation of fumes and dust. It is an experimental tumorigen. Chronic manganese poisoning is a clearly characterized disease which results from the inhalation of fumes or dusts of manganese. Exposure to heavy concentrations of dusts or fumes for as little as three months may produce the condition, but usually cases develop after 1-3 years of exposure. The central nervous system is the chief site of damage. If cases are removed from exposure shortly after the appearance of symptoms, some improvement in the patients' condition frequently occurs, though there may be some residual disturbances in gait and speech. When well established, however, the disease results in permanent disability. Exposure to dusts and fumes can possibly increase the incidence of upper respiratory infections and pneumonia. Chronic manganese poisoning begins usually with complaints of languor and sleepiness. This is followed by weakness in the legs and the development of a stolid mask-like face. The patient speaks with a slow monotonous voice. The muscular twitchings appear, varying from a fine tremor of the hands to coarse, rhythmical movements of the arms, legs and trunk. Nocturnal cramps of the leg appear about the same time. There is a slight increase in the tendon reflexes, ankle and patillar clonus, and a typical Parkinsonian slopping gait. The handwriting may be quite minute. The systems may simulate progressive bulbar paralysis, postincephalitec Parkinsonism, multiple sclerosis, amyotropic lateral sclerosis and progressive lenticulae degeneration (Welson's Disease).

MERCURY

Mercury, Hg, is a silver-white, heavy, mobile, liquid metal utilized in gold, silver, and bronze tin-plating; tanning and dyeing; feltmaking; taxidermy; textile manufacturing; photography; extracting gold and silver from ores; paints and pigments; the preparation of drugs and disinfectants in the pharmaceutical industry; and as a chemical reagent. It is also used in barometers, thermometers, fluorescent lamps, as a catalyst in the oxidation of organic compounds, and in agricultural chemicals.

Classification

The U.S. EPA weight of evidence classification for human carcinogenicity is categorized in Group D: not being a human carcinogen. No human data are available to evaluate the evidence for carcinogenicity. Animal carcinogenicity studies are inadequate.

Health Effects

Mercury can be inhaled, ingested, or absorbed through the skin. It is a primary irritant of skin and mucous membranes. It may be a skin sensitizer. Either acute or chronic exposure may produce permanent changes to affected organs and organ systems. Soluble mercury salts have violent corrosive effects on skin and mucous membranes, cause severe nausea, vomiting, abdominal pain, and bloody diarrhea; kidney damage, and death usually within 10 days. Chronic effects produce four classical signs: gingivitis, sealorrhea, increased irritability, and muscular tremors. Rarely are all four seen together in an individual case. Symptoms may include inflammation of the mouth or gums, excessive salivation, brasing of teeth, kidney damage, muscle tremors, personality changes, depression, irritability, and nervousness. Burning sensation is delayed several hours and thus gives no warning.

METHYLENE CHLORIDE

Methylene chloride, CH_2Cl_2, is a nonflammable, colorless liquid with a pleasant aromatic odor. It is also known as dichloromethane. It is used as a solvent for degreasing and cleaning fluids and as a solvent for food processing.

Classification

The weight of evidence classification given to methylene chloride is B2, recognizing this substance as a probable human carcinogen. Human carcinogenicity data is inadequate.

Health Effects

Methylene chloride can irritate the eyes, nose, and throat. It can be inhaled as a vapor, absorbed through the skin, or ingested. Methylene chloride is a mild narcotic. Effects from intoxication include headache, giddiness, stupor, irritability, numbness, and tingling in the limbs. Irritation to the eyes and upper respiratory passages occurs at higher dosages. In severe cases, observers have noted toxic encephalopathy with hallucinations, pulmonary edema, coma, and death. Cardiac arrhythmias have been produced in animals but have not been common in human experience. Exposure to this agent may cause elevated carboxy hemoglobin levels which may be significant in smokers, workers with anemia or heart disease, and those exposed to carbon monoxide.

2-METHYLNAPHTHALENE

2-Methylnaphthalene is a polycyclic aromatic hydrocarbon (PAH) compound. It is formed when fossil fuels, garbage, or any plant or animal material is burned, and, therefore, it is usually found in smoke and soot. 2-Methylnaphthalene is found in cigarette smoke, power plant emissions, and coal tar pitch.

Classification

Although not classified by USEPA, 2-methylnaphthalene is structurally similar to non-carcinogenic PAH compounds.

Health Effects

2-Methylnaphthalene is a component of PAH mixtures that occur in coal tar, tobacco smoke, and emissions from power plants and foundries. Although specific information on 2-methylnaphthalene is not available, these mixtures have toxicological effects including death, cancer, and reproductive failure.

4-METHYL-2-PENTANONE

4-Methyl-2-pentanone, $(CH_3)_2CHCH_2COCH_3$, is also known as methyl isobutyl ketone and MIBK. It is a colorless, flammable liquid with a pleasant odor. It is used as a solvent for paints, varnishes and nitrocellulose lacquers; in the manufacture of methyl amyl alcohol; in extraction processes; in organic synthesis and as a denaturant for alcohol.

Classification

MIBK has not been evaluated by the USEPA for evidence of human carcinogenic potential.

Health Effects

MIBK exposure may cause irritation of eye and mucous membranes, dermatitis, headaches, narcosis, coma, and death.

NAPHTHALENE

Naphthalene is one of the polycyclic aromatic hydrocarbon (PAH) compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Naphthalene is found in coal tar pitch used by industry as an adhesive. It may be used as insecticide.

People may be exposed to naphthalene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to naphthalene alone, but to a mixture of similar chemicals.

Classification

USEPA weight-of-evidence classification - D; not classifiable as to human carcinogenicity on the basis that no human data and inadequate data from animal bioassays exist.

Health Effects

Naphthalene is a primary irritant. It will cause erythema and dermatitis upon repeated contact. It is an allergen and may cause dermatitis in hypersensitive persons. Eye contact with naphthalene dust has caused irritation and cataracts. Ingestion or inhalation of high vapor concentrations may cause intravascular hemolysis. Eye irritation, headache, confusion, excitement, malaise, profuse sweating, nausea, vomiting, abdominal pain and bladder irritation are the initial symptoms. Progressive jaundice, hematuria, hemoglobinuria, a blockage of the renal tubules and acute renal shutdown may occur. Blood effects include: red cell fragmentation, icterus, severe anemia, leukocytosis and decreases in hemoglobin, hematocrit and red blood cell count. Liver damage is another effect of naphthalene.

NICKEL

Nickel, Ni, is a lustrous, hard ferromagnetic material. It is used for nickel plating, for various alloys, for coins, storage batteries, magnets, lightening rod tips, machinery parts, and as a catalyst for the hydrogenation of oils and other organic substances. Probably the largest use of nickel is in the manufacture of Manel metal, stainless steels, nickel-chrome resistance wires, and in alloys for electronic and space applications (Merck, 1987).

Classification

The U.S. EPA weight of evidence classification is Group A: stating nickel to be a human carcinogen. This classification is based on human data in which exposure to nickel refinery dust caused lung and nasal tumors in refinery workers, and on animal data in which carcinomas were produced in rats by inhalation and injection.

Sufficient human carcinogenicity data exists. Nickel refinery dust from pyromethallurgical sulfide nickel matte refineries is considered a human carcinogen when inhaled. Evidence of carcinogenicity includes a consistency of findings across different countries in several epidemiologic studies (Clydach, Wales; Copper Cliff, Ontario; Port Colborne, Ontario; Kristiansand Norway and Huntington, West Virginia).

Specific tumor sites (lung and nose), high relative risks, particularly for nasal cancer and dose response relationships by length of exposure have been examined. Excess risks are greatest in the dustier areas of the respective refineries.

Health Effects

Nickel and most of its salts are generally considered not to cause acute systemic poisoning. However, ingestion of large doses of nickel compounds have been shown to cause intestinal disorders, convulsions, and asphyxia. Many nickel compounds are experimental carcinogens and some are human carcinogens by inhalation. All nickel contaminated dusts are regarded as carcinogenic by inhalation. The most common effect resulting from exposure to nickel compounds is the development of the "nickel itch". This form of dermatitis occurs chiefly in persons doing nickel-plating. There is marked variation in individual susceptibility to the dermatitis. It occurs more frequently under conditions of high temperature and humidity, when the skin is moist and chiefly affects the hands and arms. Nickel carbonyl is highly irritating to the lungs and also can produce asphyxia by decomposing with the formation of carbon monoxide. These compounds are common air contaminants (Sax/Lewis, 1987).

PHENANTHRENE

Phenanthrene, $C_{14}H_{10}$, is one of the polycyclic aromatic hydrocarbon (PAH) compounds. It is a colorless, shining crystalline solid. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and onto soil and crops. Phenanthrene is found in coal tar pitch used by industry as an adhesive. It is used in dyestuffs, explosives, drug synthesis, and biochemical research.

People may be exposed to phenanthrene from environmental sources such as air, water, and soil, and from cigarette smoke and overcooked food. Typical exposures are not usually to phenanthrene alone, but to a mixture of similar chemicals.

Classification

The USEPA weight-of-evidence classification for phenanthrene is D, not classifiable as to human carcinogenicity on the basis that no human data and inadequate data from a single gavage study in rats and skin painting and injection studies in mice exists.

Health Effects

Phenanthrene is a skin photosensitizer.

PHENOLS (TOTAL)

Phenols are a class of aromatic organic compounds in which one or more hydroxy groups are attached directly to the benzene ring. this group includes phenol, pyrocatechol, resorcinol, hydroquinone, quinone, pyrogallol, o,m, and p-cresol, creosote, pentachlorophenol, other chlorophenols, bromo and iodophenols, o-phenylphenol, d-tert-butylmethylphenol, p-tert-butylphenol and dodecylthiophenol. Phenols are used in a large variety of organic compounds, just a few of which are: explosives, fertilizers, wood preservatives, paints, rubber, synthetic resins and pharmaceuticals.

Classification

Several phenols have been found to cause papillomas and carcinomas in mice. There is no specific evidence of human cancer attributed to phenolic compounds. Phenol is classed as a group D chemical. Phenols, as a group, are not classified.

Health Effects

In general the health effects of the phenol group are similar to those of phenol itself. (See phenol profile.) The following are effects of some phenolic compounds which differ from the effects of phenol:

Pyrocatechol - large doses can cause depression of the central nervous system and a prolonged blood pressure rise. It is more toxic than phenol except by inhalation.

Resorcinol - intoxication symptoms similar to those of phenol but the antipyretic action is more marked.

Hydroquinone - more toxic than phenol. Methemoglobin formation is marked, therefore oxygen carrying capacity of the blood is greatly reduced and anoxia may result.

Quinone - Asphyxia is probably important in terminal cases, due to pulmonary damage caused by excretion of quinone into the alveoli, and the not well known effects of quinone on hemoglobin.

Pyrogallol - its strong reducing action gives it a tremendous affinity for oxygen in the blood possibly causing anoxia.

Pentachlorophenol - when absorbed by animals in sufficient quantity it causes accelerated respiration and blood pressure, hyperpyrexia, hyperglycemia, glycosuria and hyperperistalsis.

PHENOL

Phenol, C_6H_5OH, is also known as carboxylic acid and hydroxybenzene. When pure it is a white or colorless solid, but it is usually used as a liquid. It has a strong, sweet odor. Phenol has many uses including: phenolic resins; epoxy resins; 2,4-D; selective solvent for lubricating oils; germicidal paints; pharmaceuticals; laboratory reagent; dyes and indicators; slimicide; general disinfectant; wood preservatives; and fertilizer.

Classification

Phenol is classed as a Group D chemical, not classifiable as to human carcinogenicity. This is based on no human data and inadequate animal data.

Health Effects

The health effects of phenol include discoloration, eczema, inflammation, necrosis, sloughing and gangrene of the skin. Oral ingestion may cause the mucous membranes in the throat and esophagus to show swelling, corrosions and necrosis along with hemorrhage and serious infiltration of the surrounding area. Hyperemia and infarcts of the lungs, bronchopneumonia, purulent bronchitis, and hyperplasia of the peribronchial tissues could be caused by a severe intoxication. Myocardial degeneration and necrosis are also possible.

Symptoms of acute phenol poisoning may include: headache, dizziness, muscular weakness, dimness of vision, ringing ears, irregular rapid breathing, weak pulse and dyspnea. If enough phenol is absorbed loss of consciousness, collapse and death could occur. (Sax, 1987)

Effects of severe chronic exposure are systemic disorders such as digestive disturbances (vomiting, difficulty swallowing, ptyalism, diarrhea, and anorexia), and nervous disorders (with headache, fainting, vertigo, and mental disturbances). Kidney, liver, spleen and pancreas damage are also characteristic. (Sax, 1987; Clayton, 1982)

POTASSIUM

Potassium, K, is an alkali metal. It is widely found in the environment. It occurs in all soils. Potassium is used in the preparation of potassium peroxide, in heat exchange alloys, as a laboratory reagent, and as a component of fertilizer.

Classification

Potassium is not classified by the USEPA for human carcinogenicity.

Health Effects

The toxicity of potassium compounds is almost always that of the anion. Potassium is a dangerous fire and explosion hazard. Potassium metal may explode violently when cut or handled. It can ignite spontaneously in moist air. Burning potassium is difficult to extinguish.

PROPYLBENZENE

Propylbenzene (1-phenylpropane), C_9H_{12}, a liquid, which is only slightly soluble in water, but is soluble in alcohol and ether. It is used in textile dyeing and printing, and as a solvent for cellulose acetate.

Classification

Not yet classified.

Health Effects

Unknown

PYRENE

Pyrene, $C_{16}H_{10}$, is a condensed ring hydrocarbon. It is a colorless solid which is derived from coal tar. Pyrene is used for biochemical research.

Classification

The USEPA weight-of-evidence classification for pyrene is D, not classifiable as to human carcinogenicity on the basis of no human data and inadequate data from animal bioassays.

Health Effects

Pyrene is absorbed by the skin and is a skin irritant. Workers exposed to 3 to 5 mg/m^3 of pyrene exhibited some teratogenic effects. Pyrene is a polycyclic aromatic hydrocarbon (PAH). The acute toxicity of pure PAHs appears low when administered orally or dermally to rats or mice. Human exposure to PAHs is almost exclusively via the gastrointestinal and respiratory tracts, and approximately 99 percent is ingested in the diet. Despite the high concentrations of pyrene to which humans may be exposed through food, there is currently little information available to implicate diet-derived PAHs as the cause of serious health effects.

SODIUM

Sodium, Na, is a silvery white alkali metal that, in the form of its compounds, comprises three percent of the earth's crust. Sodium metal is highly reactive and is not likely to be found in the environment. Sodium's major source is sodium chloride, the major inorganic component of sea water. Sodium is used in the manufacture of sodium compounds, in the manufacture of tetraethyllead, in organic synthesis, for photoelectric cells and in sodium lamps.

Classification

Sodium is not classified by the USEPA for carcinogenicity.

Health Effects

Sodium is essential to life in its ionic form. Some compounds are toxic and are dealt with specifically rather than generally. Sodium is extremely caustic to all tissues.

STYRENE

Styrene (phenylethene), C_8H_8, is a colorless to yellowish, very refractive, combustible oily liquid with a penetrating odor. It is insoluble in water, but soluble in alcohol and ether. Styrene readily undergoes polymerization when heated. It is used in polystyrene plastics and in various resins and protective coatings.

Classification

Styrene has a weight-of-evidence classification of B2, a probable human carcinogen. This is based upon evidence of leukemia in rats and mice. Human carcinogenicity data are inadequate.

Health Effects

Styrene is an irritant to eyes, nose, throat, and skin. Short-term exposure may cause prolonged reaction time and decreased manual dexterity. Acute exposure to high concentrations may produce respiratory irritation, followed by narcosis, cramps, and even death (due to respiratory center paralysis).

1,1,2,2-TETRACHLOROETHANE

1,1,2,2-Tetrachloroethane (acetylene tetrachloride), $CHCl_2$ $CHCl_2$, is a heavy, colorless, corrosive liquid. It is nonflammable, with a sweetish, chloroformlike odor. It is soluble in alcohol and ether, and slightly soluble in water. Among a variety of uses, it is used as a dry cleaning agent, as a fumigant, in cement, and in lacquers, although it's use as a solvent is declining.

Classification

1,1,2,2-Tetrachloroethane has a weight-of-evidence classification of C, a possible human carcinogen. This is based upon evidence of liver tumors in mice. Human carcinogenicity data are inadequate.

Health Effects

Points of attack for this compound are the liver, kidneys, and central nervous system. Early systemic effects include tremors, headache, numbness of limbs, and excessive sweating. Partial paralysis and blood changes have also occurred. Other physical symptoms, such as fatigue, headache, constipation, and nausea may follow. Liver dysfunction has occurred, as has pulmonary edema and renal damage. Heat decomposition results in the emission of very toxic chloride fumes.

TETRACHLOROETHENE

Tetrachloroethene, C_2Cl_4, is a colorless liquid with an ether like odor. It is also known as perchloroethylene. Tetrachloroethene is a commercially important chlorinated hydrocarbon solvent and chemical intermediate. It has been widely used as a dry-cleaning agent, textile processing solvent, heat transfer medium, in the manufacture of fluorocarbons, and for vapor degreasing in metal cleaning operations.

Classification

The USEPA weight-of-evidence for tetrachloroethene is B2, a probable human carcinogen. It has been shown to cause mononuclear cell leukemia and kidney tumors in rats, and hepatocellular adenomas and carcinomas in mice. There is inadequate data for humans.

Health Effects

Tetrachloroethene is rapidly absorbed following oral and inhalation exposure, while absorption following dermal exposure is poor. It is an eye and nose irritant. Repeated contact may cause a dry, scaly and fissured dermatitis. Acute exposure to tetrachloroethene may cause central nervous system depression, hepatic injury and anesthetic death.

Animal experiments have produced cardiac arrhythmias and renal injury. Malaise, dizziness, headache, increased perspiration, fatigue, staggering gait and slowing of mental ability are symptoms of overexposure. The principal target organs of tetrachloroethene are the central nervous system, liver, and kidneys.

TOLUENE

Toluene, C_7H_8, is also known as methylbenzene. It is a colorless liquid, with a sweet, pungent, benzene-like odor. It is derived from coal tar. Toluene is used in the manufacture of benzene, as chemical feed, as a solvent for paints and coatings, and as a fuel component.

Classification

The U.S. EPA's weight of evidence classification as to human carcinogenicity is Group D: not classified as a carcinogen based on no human data and inadequate animal data.

Health Effects

Toluene is a poison by intraperitoneal routes. It is moderately toxic by inhalation and subcutaneous routes. It is known to be a skin, eye, and respiratory tract irritant. Toluene affects the central nervous system, the kidney, the liver, and skin. Inhalation of 200 ppm of toluene for eight hours may cause impairment of coordination. With higher concentrations, these effects are increased. Acute exposure to toluene includes symptoms of headache, dizziness, fatigue, drowsiness, and lack of coordination. Chronic effects are anemia and leukopenia, with biopsies showing bone marrow hypoplasia.

1,2,4-TRIMETHYLBENZENE

1,2,4-Trimethylbenzene is also known as pseudocumene. It is a colorless liquid, with a boiling point of 169°C. It is found in coal tar, many petroleums, and in diesel exhaust fumes. 1,2,4-Trimethylbenzene is used as a solvent; in the manufacture of dyes, perfumes and resins, and for sterilizing cat gut.

Classification

The USEPA has not assigned a weight of evidence for 1,2,4-Trimethylbenzene.

Health Effects

1,2,4-Trimethylbenzene is a central nervous system depressant. Effects of exposure include: skin irritation, chemical pneumonitis if the liquid gets into the lungs, nervousness, tension, anxiety, bronchitis, hypochromic anemia, conjunctivitis, headache, fatigue, nausea, and marcosis.

1,3,5-TRIMETHYLBENZENE

1,3,5-trimethylbenzene (mesistylene), $C_6H_3(CH_3)_3$, is one of three isomers of trimethylbenzene. It is a combustible liquid, insoluble in water, but soluble in alcohol and ether. All three isomers are found in diesel exhaust. 1,3,5-trimethylbenzene is used as a solvent in dye and perfume manufacture.

Classification

Not yet classified.

Health Effects

Toxic by inhalation. Can cause nervousness, asthmatic bronchitis, hypochromic anemia, and abnormal blood coagulability. May even cause respiratory failure and death.

1,1,1-TRICHLOROETHANE

1,1,1-Trichloroethane, $C_2H_3Cl_3$, is a colorless liquid with a sweet odor. It is also known as 1,1,1-TCE and methyl chloroform. 1,1,1-TCE has found wide use as a substitute for carbon tetrachloride. It is used as a dry cleaning agent, vapor degreasing agent, in textile processing, for cleaning precision instruments, as a propellant and as a pesticide.

Classification

Weight-of-evidence classification by the USEPA is Group C, a possible human carcinogen. Documented evidence of carcinogenicity in animals is available. No evidence in humans is available.

Health Effects

Acute health effects of 1,1,1-TCE may include: eye irritation, mild conjunctivitis, dizziness, incoordination, drowsiness, increased reaction time, unconsciousness, and death. It acts as a narcotic and depresses the central nervous system. Repeated skin contact may cause a dry, scaly, and fissured dermatitis. 1,1,1-TCE may be injurious to the liver and kidneys.

VANADIUM

Vanadium is a heavy metal used in the manufacture of rust resistant steel. It occurs naturally in mineral ores.

Classification

Not classified by the U.S. EPA as to human carcinogenicity potential.

Health Effects

Vanadium compounds are toxic to humans and animals, and is considered to be an industrial hazard. Dust from vanadium and it's compounds is irritating to the respiratory tract, but the effects are not long lasting or cumulative.

XYLENES (TOTAL)

Xylene C_8H_{10}, commonly known as dimethylbenzene, is used as a solvent, a raw material for production of benzoic acid, phthalic anhydride, isophthalic, and terephthalic acids, as well as their dimethyl esters used in the manufacture of polyester fibers; dyes and other organics. It is also used for sterilizing catgut. Xylene exists in three isomeric forms: ortho meta, and para-xylene.

Classification

The weight of evidence classification for human carcinogenicity is Class D: not classifiable as to human carcinogenicity. No human data is available and animal data is inadequate.

Health Effects

Xylene is a poison by ingestion and inhalation. It may affect the central nervous system, eyes, gastrointestinal tract, blood, liver, kidneys, and skin. Xylene vapors may cause irritation to the eyes, nose, and throat. Repeated or prolonged skin contact with xylene may cause drying and defatting of the skin, which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes, and aspiration may cause chemical pneumonitis, pulmonary edema, and hemorrhage. Repeated exposure of the eyes to high concentrations of xylene vapor may cause reversible eye damage.

Acute exposure to xylene vapor may cause central nervous system depression and minor reversible effects on liver and kidneys. At high concentrations xylene vapor may cause dizziness, staggering, drowsiness, and unconsciousness. At extremely high concentrations, breathing xylene vapors may cause pulmonary edema, anorexia, nausea, vomiting, and abdominal pain.

ZINC

Zinc, Zn, is a metal with many uses in industry. It can be found in pure form or mixed with other metals to form alloys such as brass, or chemical salts such as zinc chloride. Zinc compounds are found naturally in air, soil and water, and are present in most foods.

Classification

The USEPA weight-of-evidence classification for zinc is D, not classifiable as to human carcinogenicity on the basis of inadequate evidence in humans and animals.

Health Effects

Zinc is an essential element needed by the body in low doses. It can be harmful to the body if too much is taken in. The effects of zinc compounds are variable but generally of low toxicity.

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