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GROUNDWATER AND SURFACE WATER ASSESSMENT FOR LANDFILL NUMBER 6

Canton, North Carolina

Volume III

Prepared by:

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Appendix I

APPENDIX I

OUTPUT FROM STATISTICAL ANALYSIS

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-1

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
13	PH	pH	13	5.40	9.90	6.76	1.12
	DISSOL	Total Dissolved Solids	13	6.70	13950.00	2980.59	4756.57
	CONDUCT	Specific Conductance	13	135.00	807.00	367.08	166.63
	AG	Silver	13	0.00	0.25	0.03	0.07
	AS	Arsenic	13	0.00	0.08	0.02	0.02
	BA	Barium	12	0.04	0.75	0.19	0.23
	CA	Calcium	12	0.01	109.00	31.75	39.78
	CD	Cadmium	11	0.00	0.01	0.00	0.00
	CR	Chromium	13	0.00	0.30	0.04	0.08
	FE	Iron	13	1.30	118.00	44.53	41.64
	HG	Mercury	13	0.00	0.00	0.00	0.00
	MN	Manganese	12	0.02	0.88	0.34	0.36
	NA	Sodium	12	21.60	2320.00	251.92	653.01
	NI	Nickel	12	0.02	0.47	0.10	0.12
	PB	Lead	13	0.02	0.33	0.13	0.14
	SE	Selenium	13	0.00	0.03	0.00	0.01
	CL	Chloride	13	1.00	7.18	3.48	2.23
	F	Fluoride	13	0.05	1.00	0.34	0.26
	NO2	Nitrite	12	0.00	1.00	0.11	0.28
	PHEN	Total Phenols	13	0.00	0.14	0.02	0.04
	SO4	Sulfate	13	27.00	900.00	223.38	239.85
	TOC	Total Organic Carbon	13	0.05	38.00	10.47	12.30
	TOH	Total Organic Halogens	13	0.01	2.35	0.32	0.67

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-10

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
21	PH	pH	20	5.00	6.44	5.84	0.50
	DISSOL	Total Dissolved Solids	20	7.50	684.00	80.57	144.61
	CONDUCT	Specific Conductance	20	25.00	106.00	36.30	16.92
	AG	Silver	21	0.00	0.25	0.04	0.09
	AS	Arsenic	20	0.00	0.08	0.01	0.02
	BA	Barium	19	0.01	0.25	0.09	0.06
	CA	Calcium	20	0.45	3.60	1.80	1.01
	CD	Cadmium	21	0.00	0.01	0.00	0.00
	CR	Chromium	21	0.00	0.03	0.01	0.01
	FE	Iron	21	0.02	19.20	3.08	5.10
	HG	Mercury	20	0.00	0.00	0.00	0.00
	MN	Manganese	20	0.00	2.40	0.23	0.53
	NA	Sodium	20	1.00	5.30	2.41	1.39
	NI	Nickel	20	0.00	0.06	0.02	0.01
	PB	Lead	19	0.00	15.40	0.83	3.53
	SE	Selenium	20	0.00	0.03	0.00	0.01
	CL	Chloride	20	0.25	11.50	2.36	2.73
	F	Fluoride	20	0.04	0.50	0.11	0.12
	NO2	Nitrite	19	0.00	0.08	0.02	0.02
	PHEN	Total Phenols	20	0.00	3.00	0.31	0.92
	SO4	Sulfate	20	1.00	30.00	7.29	8.41
	TOC	Total Organic Carbon	20	0.25	10.80	2.27	2.74
	TOH	Total Organic Halogens	18	0.01	0.18	0.03	0.04

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-11

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
20	PH	pH	20	4.50	7.27	5.38	0.65
	DISSOL	Total Dissolved Solids	20	6.80	692.00	104.89	143.03
	CONDUCT	Specific Conductance	20	62.00	550.00	105.20	105.08
	AG	Silver	20	0.00	0.25	0.03	0.08
	AS	Arsenic	20	0.00	0.08	0.01	0.02
	BA	Barium	19	0.05	1.10	0.17	0.25
	CA	Calcium	19	1.00	5.07	2.43	1.22
	CD	Cadmium	20	0.00	0.01	0.00	0.00
	CR	Chromium	20	0.01	0.16	0.02	0.03
	FE	Iron	20	0.02	327.00	27.54	73.59
	HG	Mercury	20	0.00	0.00	0.00	0.00
	MN	Manganese	19	0.00	0.50	0.06	0.11
	NA	Sodium	19	2.50	7.95	4.41	1.23
	NI	Nickel	19	0.00	0.12	0.02	0.02
	PB	Lead	20	0.01	11.80	0.61	2.63
	SE	Selenium	20	0.00	0.03	0.00	0.01
	CL	Chloride	20	0.50	15.00	9.06	3.45
	F	Fluoride	19	0.02	0.50	0.11	0.12
	NO2	Nitrite	18	0.00	5.00	0.39	1.22
	PHEN	Total Phenols	20	0.00	3.00	0.31	0.92
	SO4	Sulfate	20	0.50	21.00	3.95	5.26
	TOC	Total Organic Carbon	20	0.08	19.10	4.40	5.18
	TOH	Total Organic Halogens	18	0.00	0.25	0.05	0.06

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-12

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
21	PH	pH	21	5.20	7.89	6.03	0.67
	DISSOL	Total Dissolved Solids	21	6.80	732.00	141.75	150.07
	CONDUCT	Specific Conductance	21	44.00	740.00	99.05	148.07
	AG	Silver	21	0.00	0.25	0.03	0.07
	AS	Arsenic	21	0.00	0.08	0.01	0.02
	BA	Barium	20	0.03	0.50	0.11	0.11
	CA	Calcium	20	0.39	6.70	2.99	2.16
	CD	Cadmium	20	0.00	0.02	0.00	0.00
	CR	Chromium	21	0.00	0.07	0.02	0.02
	FE	Iron	21	0.02	86.40	10.86	22.81
	HG	Mercury	21	0.00	0.00	0.00	0.00
	MN	Manganese	21	0.01	8.75	0.67	1.91
	NA	Sodium	20	2.10	7.90	4.12	1.56
	NI	Nickel	20	0.00	0.07	0.02	0.02
	PB	Lead	21	0.00	0.05	0.02	0.01
	SE	Selenium	21	0.00	0.03	0.00	0.01
	CL	Chloride	21	1.00	6.50	3.12	1.28
	F	Fluoride	21	0.05	0.50	0.12	0.11
	NO2	Nitrite	19	0.00	0.63	0.07	0.19
	PHEN	Total Phenols	21	0.00	3.75	0.34	1.02
	SO4	Sulfate	21	1.00	34.00	13.79	7.50
	TOC	Total Organic Carbon	21	0.05	11.00	3.63	3.13
	TOH	Total Organic Halogens	19	0.00	0.12	0.04	0.04

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-13

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
13	PH	pH	13	5.30	7.41	6.05	0.58
	DISSOL	Total Dissolved Solids	13	60.00	4200.00	2470.38	1601.76
	CONDUCT	Specific Conductance	13	34.00	340000.00	28864.31	93505.30
	AG	Silver	13	0.00	0.25	0.06	0.11
	AS	Arsenic	13	0.00	0.08	0.01	0.02
	BA	Barium	12	0.05	1.39	0.44	0.45
	CA	Calcium	13	0.20	213.00	128.04	76.08
	CD	Cadmium	13	0.00	0.02	0.01	0.01
	CR	Chromium	13	0.00	0.13	0.05	0.05
	FE	Iron	13	0.17	196.00	59.05	72.79
	HG	Mercury	13	0.00	2.40	0.19	0.67
	MN	Manganese	12	0.34	17.00	9.74	5.98
	NA	Sodium	13	2.10	1424.00	436.00	435.07
	NI	Nickel	13	0.01	0.12	0.05	0.04
	PB	Lead	13	0.00	11.40	0.91	3.15
	SE	Selenium	13	0.00	0.07	0.01	0.02
	CL	Chloride	13	2.00	268.00	155.29	82.97
	F	Fluoride	13	0.03	0.70	0.23	0.23
	NO2	Nitrite	11	0.00	0.07	0.02	0.02
	PHEN	Total Phenols	13	0.00	3.75	0.52	1.27
	SO4	Sulfate	13	2.50	4518.00	1675.81	1339.24
	TOC	Total Organic Carbon	13	0.50	25.00	9.86	7.86
	TOH	Total Organic Halogens	11	0.01	111.00	10.21	33.43

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-14

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
7	PH	pH	7	5.66	6.70	6.19	0.41
	DISSOL	Total Dissolved Solids	7	30.00	160.00	94.57	43.81
	CONDUCT	Specific Conductance	7	109.00	910.00	252.43	293.52
	AG	Silver	7	0.00	0.25	0.07	0.09
	AS	Arsenic	7	0.00	0.01	0.00	0.00
	BA	Barium	5	0.01	11.68	3.43	4.86
	CA	Calcium	7	0.01	92.00	26.93	32.43
	CD	Cadmium	7	0.00	0.71	0.13	0.26
	CR	Chromium	7	0.00	4.00	1.04	1.48
	FE	Iron	7	0.67	2100.00	532.25	779.70
	HG	Mercury	7	0.00	0.00	0.00	0.00
	MN	Manganese	7	0.27	50.00	12.55	18.03
	NA	Sodium	7	6.75	40.00	12.98	12.02
	NI	Nickel	7	0.00	2.20	0.55	0.81
	PB	Lead	7	0.01	0.28	0.09	0.10
	SE	Selenium	7	0.00	0.01	0.00	0.00
	CL	Chloride	7	13.00	40.00	22.60	8.65
	F	Fluoride	7	0.05	0.67	0.20	0.23
	NO2	Nitrite	5	0.01	0.03	0.02	0.01
	PHEN	Total Phenols	7	0.00	3.75	1.02	1.73
	SO4	Sulfate	7	0.50	5.00	2.09	1.49
	TOC	Total Organic Carbon	7	1.40	6.70	3.83	2.06
	TOH	Total Organic Halogens	5	0.01	0.08	0.02	0.03

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-15

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
7	PH	pH	7	6.03	7.00	6.48	0.36
	DISSOL	Total Dissolved Solids	7	5.00	120.00	41.29	36.91
	CONDUCT	Specific Conductance	7	25.00	320.00	81.29	106.15
	AG	Silver	7	0.00	0.25	0.06	0.09
	AS	Arsenic	7	0.00	0.01	0.00	0.00
	BA	Barium	5	0.10	4.20	2.15	1.48
	CA	Calcium	7	2.57	32.00	9.66	10.04
	CD	Cadmium	7	0.00	0.05	0.01	0.02
	CR	Chromium	7	0.00	0.97	0.25	0.33
	FE	Iron	7	2.85	1200.00	290.58	413.13
	HG	Mercury	7	0.00	0.00	0.00	0.00
	MN	Manganese	7	0.14	26.00	7.31	9.86
	NA	Sodium	7	2.46	32.00	7.42	10.87
	NI	Nickel	7	0.00	0.30	0.10	0.10
	PB	Lead	7	0.01	0.20	0.06	0.07
	SE	Selenium	7	0.00	0.01	0.00	0.00
	CL	Chloride	7	0.50	3.70	1.24	1.23
	F	Fluoride	7	0.05	0.27	0.14	0.11
	NO2	Nitrite	5	0.01	0.20	0.05	0.08
	PHEN	Total Phenols	7	0.00	3.75	1.03	1.73
	SO4	Sulfate	7	1.10	7.20	2.83	2.34
	TOC	Total Organic Carbon	7	0.50	3.00	2.01	0.84
	TOH	Total Organic Halogens	5	0.01	0.03	0.01	0.01

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-1A

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
7	PH	pH	7	6.00	6.70	6.39	0.26
	DISSOL	Total Dissolved Solids	7	31.00	59.00	47.71	10.45
	CONDUCT	Specific Conductance	7	26.00	56.00	41.00	11.03
	AG	Silver	7	0.00	0.25	0.04	0.09
	AS	Arsenic	7	0.00	0.01	0.00	0.00
	BA	Barium	5	0.05	2.69	1.07	1.35
	CA	Calcium	7	2.44	24.00	7.37	7.52
	CD	Cadmium	7	0.00	0.02	0.01	0.01
	CR	Chromium	7	0.00	0.52	0.14	0.18
	FE	Iron	7	2.08	540.00	141.52	191.14
	HG	Mercury	7	0.00	0.00	0.00	0.00
	MN	Manganese	7	0.21	7.00	1.84	2.36
	NA	Sodium	7	2.16	5.70	3.49	1.52
	NI	Nickel	7	0.00	0.26	0.07	0.09
	PB	Lead	7	0.01	0.05	0.02	0.02
	SE	Selenium	7	0.00	0.01	0.00	0.00
	CL	Chloride	7	0.50	1.90	0.97	0.54
	F	Fluoride	7	0.05	0.70	0.20	0.24
	NO2	Nitrite	6	0.01	0.05	0.02	0.02
	PHEN	Total Phenols	7	0.00	3.75	0.97	1.66
	SO4	Sulfate	7	0.50	22.00	5.04	7.64
	TOC	Total Organic Carbon	7	0.25	4.20	2.02	1.74
	TOH	Total Organic Halogens	5	0.00	0.02	0.01	0.01

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-2

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
21	PH	pH	20	6.00	11.50	9.07	1.33
	DISSOL	Total Dissolved Solids	19	9.40	13400.00	7873.07	3272.75
	CONDUCT	Specific Conductance	20	115.60	14500.00	8599.63	4108.85
	AG	Silver	20	0.00	0.25	0.04	0.08
	AS	Arsenic	20	0.00	0.77	0.12	0.18
	BA	Barium	20	0.01	0.50	0.10	0.11
	CA	Calcium	19	0.01	43.90	9.67	11.66
	CD	Cadmium	18	0.00	0.01	0.00	0.00
	CR	Chromium	20	0.01	0.17	0.03	0.04
	FE	Iron	20	0.02	23.50	6.49	6.26
	HG	Mercury	20	0.00	0.00	0.00	0.00
	MN	Manganese	19	0.02	4.00	0.42	1.01
	NA	Sodium	19	2.98	21080.00	3288.58	4415.91
	NI	Nickel	19	0.03	0.82	0.27	0.20
	PB	Lead	20	0.01	5.39	0.35	1.19
	SE	Selenium	20	0.00	0.03	0.01	0.01
	CL	Chloride	21	2.00	520.00	277.80	180.85
	F	Fluoride	21	0.05	21.00	5.68	5.15
	NO2	Nitrite	19	0.00	1.90	0.15	0.44
	PHEN	Total Phenols	18	0.01	5.40	0.73	1.47
	SO4	Sulfate	20	46.00	2300.00	1417.07	647.26
	TOC	Total Organic Carbon	20	0.50	900.00	356.46	256.46
	TOH	Total Organic Halogens	19	0.01	496.00	26.61	113.67

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-3A

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
12	PH	pH	12	6.50	8.83	7.42	0.61
	DISSOL	Total Dissolved Solids	12	9.80	220.00	109.07	55.26
	CONDUCT	Specific Conductance	12	83.00	1100.00	197.67	285.40
	AG	Silver	12	0.00	0.25	0.03	0.07
	AS	Arsenic	12	0.00	0.01	0.00	0.00
	BA	Barium	11	0.01	0.50	0.15	0.18
	CA	Calcium	12	1.10	16.57	8.36	5.35
	CD	Cadmium	12	0.00	0.01	0.00	0.00
	CR	Chromium	12	0.00	0.03	0.01	0.01
	FE	Iron	12	0.13	39.50	10.14	11.45
	HG	Mercury	12	0.00	0.00	0.00	0.00
	MN	Manganese	11	0.01	0.06	0.03	0.02
	NA	Sodium	12	5.70	9.40	7.65	1.17
	NI	Nickel	12	0.00	0.04	0.02	0.01
	PB	Lead	12	0.00	7.59	0.65	2.19
	SE	Selenium	12	0.00	0.01	0.00	0.00
	CL	Chloride	12	0.50	7.50	2.79	2.56
	F	Fluoride	12	0.05	0.25	0.15	0.06
	NO2	Nitrite	11	0.00	0.05	0.02	0.02
	PHEN	Total Phenols	12	0.00	3.75	0.57	1.32
	SO4	Sulfate	12	6.10	32.00	13.77	7.01
	TOC	Total Organic Carbon	12	0.25	9.30	4.00	3.36
	TOH	Total Organic Halogens	10	0.01	0.16	0.03	0.05

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-4

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
21	PH	pH	20	4.10	6.30	5.55	0.61
	DISSOL	Total Dissolved Solids	21	6.00	2600.00	1031.62	873.24
	CONDUCT	Specific Conductance	21	57.00	270000.00	13978.48	58672.99
	AG	Silver	21	0.00	0.25	0.04	0.09
	AS	Arsenic	21	0.00	0.08	0.01	0.02
	BA	Barium	20	0.05	0.65	0.15	0.16
	CA	Calcium	20	0.57	140.00	44.70	45.53
	CD	Cadmium	20	0.00	0.02	0.01	0.01
	CR	Chromium	21	0.01	0.08	0.02	0.02
	FE	Iron	21	0.02	335.00	147.22	134.07
	HG	Mercury	21	0.00	0.00	0.00	0.00
	MN	Manganese	20	0.06	13.00	3.71	4.11
	NA	Sodium	20	2.10	230.00	78.03	85.13
	NI	Nickel	20	0.00	8.00	0.42	1.78
	PB	Lead	21	0.00	11.70	0.58	2.55
	SE	Selenium	21	0.00	0.10	0.01	0.03
	CL	Chloride	21	1.00	330.00	127.88	118.93
	F	Fluoride	21	0.02	193.00	9.41	42.07
	NO2	Nitrite	20	0.00	0.70	0.07	0.17
	PHEN	Total Phenols	21	0.00	3.75	0.34	1.02
	SO4	Sulfate	21	2.00	1500.00	465.50	531.89
	TOC	Total Organic Carbon	21	0.50	28.00	7.37	7.06
	TOH	Total Organic Halogens	19	0.02	24.20	1.40	5.53

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-5A

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
13	PH	pH	13	5.40	6.50	5.92	0.38
	DISSOL	Total Dissolved Solids	13	31.00	151.00	83.77	38.54
	CONDUCT	Specific Conductance	13	65.00	900.00	167.54	223.71
	AG	Silver	13	0.00	0.25	0.04	0.09
	AS	Arsenic	13	0.00	0.08	0.01	0.02
	BA	Barium	12	0.05	0.50	0.24	0.16
	CA	Calcium	13	0.20	12.50	4.38	2.92
	CD	Cadmium	13	0.00	0.01	0.00	0.00
	CR	Chromium	13	0.01	0.08	0.03	0.02
	FE	Iron	13	0.31	80.50	29.88	23.61
	HG	Mercury	13	0.00	0.00	0.00	0.00
	MN	Manganese	12	0.45	2.50	0.97	0.67
	NA	Sodium	13	3.90	14.00	8.87	2.89
	NI	Nickel	13	0.01	0.07	0.03	0.02
	PB	Lead	13	0.00	25.70	1.99	7.12
	SE	Selenium	13	0.00	0.03	0.01	0.01
	CL	Chloride	13	4.00	37.70	11.45	8.44
	F	Fluoride	13	0.05	0.50	0.16	0.15
	NO2	Nitrite	11	0.00	1.50	0.16	0.45
	PHEN	Total Phenols	13	0.00	3.75	0.53	1.27
	SO4	Sulfate	13	4.20	54.00	17.19	16.20
	TOC	Total Organic Carbon	12	0.25	62.00	9.86	17.51
	TOH	Total Organic Halogens	11	0.00	3.40	0.33	1.02

Champion International
Canton Landfill No. 6
Canton, North Carolina

Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-6

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
21	PH	pH	21	4.80	6.21	5.54	0.43
	DISSOL	Total Dissolved Solids	21	6.60	2452.00	355.08	654.64
	CONDUCT	Specific Conductance	21	80.00	1300.00	194.52	257.29
	AG	Silver	21	0.00	0.25	0.03	0.07
	AS	Arsenic	21	0.00	0.08	0.01	0.02
	BA	Barium	20	0.05	0.50	0.12	0.13
	CA	Calcium	20	0.61	15.99	5.85	4.56
	CD	Cadmium	20	0.00	0.01	0.00	0.00
	CR	Chromium	21	0.01	0.21	0.03	0.04
	FE	Iron	21	0.02	50.87	10.47	14.25
	HG	Mercury	21	0.00	0.01	0.00	0.00
	MN	Manganese	20	0.05	3.60	0.45	0.77
	NA	Sodium	20	5.80	15.10	8.51	2.57
	NI	Nickel	20	0.01	0.06	0.02	0.01
	PB	Lead	20	0.00	50.80	2.56	11.36
	SE	Selenium	21	0.00	0.03	0.01	0.01
	CL	Chloride	21	4.00	43.00	11.33	9.99
	F	Fluoride	21	0.05	0.80	0.15	0.19
	NO2	Nitrite	19	0.00	6.40	0.40	1.47
	PHEN	Total Phenols	21	0.00	3.75	0.34	1.02
	SO4	Sulfate	21	8.90	47.10	23.18	8.92
	TOC	Total Organic Carbon	21	0.25	61.00	9.48	13.85
	TOH	Total Organic Halogens	19	0.00	0.12	0.03	0.03

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Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-7A

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
13	PH	pH	13	5.20	6.50	5.97	0.36
	DISSOL	Total Dissolved Solids	13	71.00	275.00	162.00	60.52
	CONDUCT	Specific Conductance	13	63.00	2400.00	374.62	615.28
	AG	Silver	13	0.00	0.25	0.04	0.09
	AS	Arsenic	13	0.00	0.08	0.01	0.02
	BA	Barium	12	0.05	0.50	0.15	0.13
	CA	Calcium	13	0.57	31.00	15.08	8.61
	CD	Cadmium	13	0.00	0.02	0.01	0.01
	CR	Chromium	13	0.00	0.04	0.02	0.01
	FE	Iron	13	0.13	79.70	23.49	30.25
	HG	Mercury	13	0.00	0.00	0.00	0.00
	MN	Manganese	12	0.14	20.31	3.39	5.57
	NA	Sodium	13	4.30	9.00	5.89	1.43
	NI	Nickel	13	0.01	0.06	0.03	0.02
	PB	Lead	13	0.00	13.90	1.09	3.85
	SE	Selenium	13	0.00	0.03	0.01	0.01
	CL	Chloride	13	2.00	30.70	12.73	9.91
	F	Fluoride	13	0.05	0.50	0.13	0.13
	NO2	Nitrite	12	0.00	0.11	0.03	0.04
	PHEN	Total Phenols	12	0.00	5.00	1.02	1.85
	SO4	Sulfate	13	2.50	175.00	70.03	49.24
	TOC	Total Organic Carbon	13	0.25	39.80	9.14	12.06
	TOH	Total Organic Halogens	11	0.01	0.07	0.02	0.02

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Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-8

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
19	PH	pH	19	5.30	6.82	6.07	0.56
	DISSOL	Total Dissolved Solids	19	5.10	864.00	199.32	249.41
	CONDUCT	Specific Conductance	19	64.00	740.00	113.74	152.37
	AG	Silver	19	0.00	0.25	0.04	0.09
	AS	Arsenic	19	0.00	0.08	0.01	0.02
	BA	Barium	18	0.03	0.90	0.16	0.21
	CA	Calcium	18	0.22	27.30	4.43	6.24
	CD	Cadmium	18	0.00	0.02	0.00	0.00
	CR	Chromium	19	0.01	0.14	0.02	0.03
	FE	Iron	19	0.57	230.00	23.18	51.90
	HG	Mercury	19	0.00	0.00	0.00	0.00
	MN	Manganese	18	0.01	1.40	0.20	0.32
	NA	Sodium	18	2.50	11.30	5.91	2.05
	NI	Nickel	18	0.01	3.00	0.19	0.70
	PB	Lead	19	0.00	30.70	1.67	7.03
	SE	Selenium	19	0.00	0.02	0.00	0.00
	CL	Chloride	19	1.00	8.50	3.03	2.15
	F	Fluoride	19	0.05	0.90	0.20	0.20
	NO2	Nitrite	18	0.00	0.45	0.05	0.11
	PHEN	Total Phenols	19	0.00	3.75	0.37	1.07
	SO4	Sulfate	19	7.50	70.00	22.99	16.58
	TOC	Total Organic Carbon	19	0.25	23.00	4.93	5.66
	TOH	Total Organic Halogens	17	0.01	0.30	0.04	0.07

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Descriptive Statistics for
Groundwater Geochemistry Data

WELL=MW-9

N Obs	Variable	Label	N	Minimum	Maximum	Mean	Std Dev
19	PH	pH	19	4.80	6.50	5.62	0.57
	DISSOL	Total Dissolved Solids	19	7.00	744.00	102.79	160.09
	CONDUCT	Specific Conductance	19	27.00	149.00	48.32	27.28
	AG	Silver	19	0.00	0.25	0.03	0.08
	AS	Arsenic	19	0.00	0.08	0.01	0.02
	BA	Barium	18	0.01	0.30	0.11	0.09
	CA	Calcium	18	0.19	6.00	2.06	1.64
	CD	Cadmium	19	0.00	0.01	0.00	0.00
	CR	Chromium	19	0.00	0.08	0.02	0.02
	FE	Iron	19	0.02	73.80	12.63	22.23
	HG	Mercury	19	0.00	0.00	0.00	0.00
	MN	Manganese	18	0.00	1.07	0.24	0.32
	NA	Sodium	18	1.50	8.58	3.36	2.03
	NI	Nickel	18	0.00	0.06	0.02	0.01
	PB	Lead	19	0.00	28.40	1.51	6.51
	SE	Selenium	19	0.00	0.03	0.01	0.01
	CL	Chloride	19	0.25	9.50	1.95	2.53
	F	Fluoride	19	0.03	0.33	0.11	0.09
	NO2	Nitrite	18	0.00	0.72	0.06	0.17
	PHEN	Total Phenols	19	0.00	3.00	0.32	0.94
	SO4	Sulfate	19	0.50	32.00	11.71	8.87
	TOC	Total Organic Carbon	19	0.25	39.00	4.13	8.61
	TOH	Total Organic Halogens	17	0.01	13.70	0.96	3.31

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Analysis of Variance for

General Linear Models Procedure
Class Level Information

Class	Levels	Values
WELL	16	MW-1 MW-10 MW-11 MW-12 MW-13 MW-14 MW-15 MW-1A MW-2 MW-3A MW-4 MW-5A MW-6 MW-7A MW-8 MW-9

Number of observations in data set = 248

Group	Obs	Dependent Variables
1	245	PH
2	245	LDISSOL
3	246	LCONDUCT
4	247	LAG LCR LFE
5	246	LAS LHG LSE LSO4
6	228	LBA
7	238	LCA LNA LNI
8	239	LCD
9	235	LMN
10	244	LPB
11	247	LCL
12	246	LF
13	223	LNO2
14	243	LPHEN
15	245	LTOC
16	217	LTOH

NOTE: Variables in each group are consistent with respect to the presence or absence of missing values.

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: PH pH

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	247.97740437	7.99927111	19.16	0.0001
Error	213	88.93219563	0.41752205		
Corrected Total	244	336.90960000			

R-Square	C.V.	Root MSE	PH Mean
0.736035	10.38126	0.64615946	6.22428571

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	230.88990345	15.39266023	36.87	0.0001
DATENUM(WELL)	16	17.08750093	1.06796881	2.56	0.0012

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	12.00150306	0.80010020	1.92	0.0230
DATENUM(WELL)	16	17.08750093	1.06796881	2.56	0.0012

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	12.00150306	0.80010020	0.75	0.7094

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	7.47174049	7.47174049	7.00	0.0176

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.31115404	0.31115404	0.29	0.5968

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.07716524	0.07716524	0.07	0.7915

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.00001271	0.00001271	0.00	0.9973

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: PH pH

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.15378213	0.15378213	0.14	0.7093

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.35885379	0.35885379	0.34	0.5702

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.02131015	0.02131015	0.02	0.8894

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.05622665	0.05622665	0.05	0.8214

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.01601740	0.01601740	0.01	0.9041

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.16616797	0.16616797	0.16	0.6985

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.25320425	0.25320425	0.24	0.6329

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.07880200	0.07880200	0.07	0.7894

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.78604793	0.78604793	0.74	0.4036

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LDISSOL Log of Total Dissolved Solids

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	548.45003433	17.69193659	16.68	0.0001
Error	213	225.87271992	1.06043530		
Corrected Total	244	774.32275424			

R-Square	C.V.	Root MSE	LDISSOL Mean
0.708296	19.93323	1.02977440	5.16611830

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	470.77908363	31.38527224	29.60	0.0001
DATENUM(WELL)	16	77.67095070	4.85443442	4.58	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	51.57434599	3.43828973	3.24	0.0001
DATENUM(WELL)	16	77.67095070	4.85443442	4.58	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	51.57434599	3.43828973	0.71	0.7452

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	2.37896527	2.37896527	0.49	0.4940

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.37846978	0.37846978	0.08	0.7837

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	16.74395189	16.74395189	3.45	0.0818

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.08291251	0.08291251	0.02	0.8977

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LDISSOL Log of Total Dissolved Solids

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.25775916	0.25775916	0.05	0.8207

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.03501919	0.03501919	0.01	0.9334

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	5.62832430	5.62832430	1.16	0.2976

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	1.41263596	1.41263596	0.29	0.5970

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	22.70408694	22.70408694	4.68	0.0461

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.28486168	0.28486168	0.06	0.8117

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.00212200	0.00212200	0.00	0.9836

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.38092446	0.38092446	0.08	0.7830

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.76611153	0.76611153	0.16	0.6964

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCONDUCT Log of Specific Conductance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	624.35517455	20.14048950	30.76	0.0001
Error	214	140.10312635	0.65468751		
Corrected Total	245	764.45830089			

R-Square	C.V.	Root MSE	LCONDUCT Mean
0.816729	15.57532	0.80912762	5.19493347

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	515.45561475	34.36370765	52.49	0.0001
DATENUM(WELL)	16	108.89955980	6.80622249	10.40	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	74.74237733	4.98282516	7.61	0.0001
DATENUM(WELL)	16	108.89955980	6.80622249	10.40	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	74.74237733	4.98282516	0.73	0.7244

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	0.25286805	0.25286805	0.04	0.8496

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	1.63483621	1.63483621	0.24	0.6307

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	35.77616407	35.77616407	5.26	0.0358

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.16433867	0.16433867	0.02	0.8785

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCONDUCT Log of Specific Conductance

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.33083527	0.33083527	0.05	0.8283

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.30115939	0.30115939	0.04	0.8360

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.21610414	0.21610414	0.03	0.8608

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	1.23555279	1.23555279	0.18	0.6757

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	39.45331504	39.45331504	5.80	0.0285

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	1.66868592	1.66868592	0.25	0.6272

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.55173645	1.55173645	0.23	0.6395

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	4.30976205	4.30976205	0.63	0.4378

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.69665749	0.69665749	0.10	0.7532

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LAG Log of Silver

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	95.41912407	3.07803626	1.21	0.2120
Error	215	544.72225242	2.53359187		
Corrected Total	246	640.14137649			

R-Square	C.V.	Root MSE	LAG Mean
0.149059	-32.71287	1.59172607	-4.86574894

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	23.61866262	1.57457751	0.62	0.8558
DATENUM(WELL)	16	71.80046144	4.48752884	1.77	0.0365

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	27.62835458	1.84189031	0.73	0.7557
DATENUM(WELL)	16	71.80046144	4.48752884	1.77	0.0365

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	27.62835458	1.84189031	0.41	0.9539

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.52907347	1.52907347	0.34	0.5675

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.06036516	0.06036516	0.01	0.9091

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.50469204	0.50469204	0.11	0.7417

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	13.36751584	13.36751584	2.98	0.1036

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LAG Log of Silver

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	10.67019514	10.67019514	2.38	0.1426

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.77961072	0.77961072	0.17	0.6824

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	1.61960548	1.61960548	0.36	0.5564

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.32845715	0.32845715	0.07	0.7902

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.01147959	0.01147959	0.00	0.9603

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.23010861	0.23010861	0.05	0.8237

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.05900819	0.05900819	0.01	0.9101

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.23010861	0.23010861	0.05	0.8237

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.45655337	0.45655337	0.10	0.7539

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCR Log of Chromium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	141.24808672	4.55638989	4.73	0.0001
Error	215	207.05805794	0.96306073		
Corrected Total	246	348.30614466			

R-Square	C.V.	Root MSE	LCR Mean
0.405529	-23.96153	0.98135658	-4.09555023

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	96.77767093	6.45184473	6.70	0.0001
DATENUM(WELL)	16	44.47041579	2.77940099	2.89	0.0003

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	43.72570710	2.91504714	3.03	0.0002
DATENUM(WELL)	16	44.47041579	2.77940099	2.89	0.0003

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	43.72570710	2.91504714	1.05	0.4611

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	6.32528727	6.32528727	2.28	0.1509

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.07113004	0.07113004	0.03	0.8749

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.17071605	0.17071605	0.06	0.8074

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	10.79280626	10.79280626	3.88	0.0663

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCR Log of Chromium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	7.96635285	7.96635285	2.87	0.1098

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	4.45153876	4.45153876	1.60	0.2238

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.00717553	0.00717553	0.00	0.9601

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	1.16981824	1.16981824	0.42	0.5257

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	1.53550996	1.53550996	0.55	0.4681

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	1.91889515	1.91889515	0.69	0.4183

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	4.55937459	4.55937459	1.64	0.2185

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.02531895	0.02531895	0.01	0.9251

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.51940172	0.51940172	0.19	0.6713

Champion International
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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LFE Log of Iron

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	804.34201477	25.94651661	6.35	0.0001
Error	215	878.76225682	4.08726631		
Corrected Total	246	1683.10427160			

R-Square	C.V.	Root MSE	LFE Mean
0.477892	123.4087	2.02169887	1.63821442

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	488.12530939	32.54168729	7.96	0.0001
DATENUM(WELL)	16	316.21670538	19.76354409	4.84	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	107.04661975	7.13644132	1.75	0.0442
DATENUM(WELL)	16	316.21670538	19.76354409	4.84	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	107.04661975	7.13644132	0.36	0.9724

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	5.71092619	5.71092619	0.29	0.5983

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	5.12925782	5.12925782	0.26	0.6174

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.45516209	0.45516209	0.02	0.8813

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	21.99739347	21.99739347	1.11	0.3071

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LFE Log of Iron

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	15.42192560	15.42192560	0.78	0.3901

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	11.69400769	11.69400769	0.59	0.4530

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	26.56083438	26.56083438	1.34	0.2634

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	4.81144508	4.81144508	0.24	0.6284

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	6.02640818	6.02640818	0.30	0.5884

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	1.50501020	1.50501020	0.08	0.7861

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.02878435	0.02878435	0.00	0.9700

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.14283385	0.14283385	0.01	0.9333

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	12.40806978	12.40806978	0.63	0.4397

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LAS Log of Arsenic

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	128.86208358	4.15684141	2.87	0.0001
Error	214	310.09247048	1.44903024		
Corrected Total	245	438.95455406			

R-Square	C.V.	Root MSE	LAS Mean
0.293566	-22.57582	1.20375672	-5.33206162

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	105.06213556	7.00414237	4.83	0.0001
DATENUM(WELL)	16	23.79994802	1.48749675	1.03	0.4298

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	8.58194732	0.57212982	0.39	0.9794
DATENUM(WELL)	16	23.79994802	1.48749675	1.03	0.4298

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	8.58194732	0.57212982	0.38	0.9643

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	3.30566543	3.30566543	2.22	0.1555

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.14871894	0.14871894	0.10	0.7559

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.76990104	0.76990104	0.52	0.4823

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.05843880	0.05843880	0.04	0.8454

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LAS Log of Arsenic

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.05843880	0.05843880	0.04	0.8454

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.07782233	0.07782233	0.05	0.8220

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.01119134	0.01119134	0.01	0.9320

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.91607580	0.91607580	0.62	0.4441

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.07054420	0.07054420	0.05	0.8304

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.90737454	0.90737454	0.61	0.4462

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.48586245	0.48586245	0.33	0.5756

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.67486226	0.67486226	0.45	0.5102

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.00152204	0.00152204	0.00	0.9749

Champion International
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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LHG Log of Mercury

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	55.21701727	1.78119411	1.47	0.0590
Error	214	258.45692214	1.20774263		
Corrected Total	245	313.67393941			

R-Square	C.V.	Root MSE	LHG Mean
0.176033	-14.19105	1.09897344	-7.74413068

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	39.47692572	2.63179505	2.18	0.0079
DATENUM(WELL)	16	15.74009154	0.98375572	0.81	0.6684

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	16.05363361	1.07024224	0.89	0.5804
DATENUM(WELL)	16	15.74009154	0.98375572	0.81	0.6684

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	16.05363361	1.07024224	1.09	0.4330

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.03880923	1.03880923	1.06	0.3194

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.40701600	0.40701600	0.41	0.5292

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	2.67851003	2.67851003	2.72	0.1184

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.03508423	0.03508423	0.04	0.8526

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Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LHG Log of Mercury

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.29413702	0.29413702	0.30	0.5921

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.15585450	0.15585450	0.16	0.6959

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	2.24751785	2.24751785	2.28	0.1502

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.39642398	0.39642398	0.40	0.5345

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.77695257	0.77695257	0.79	0.3873

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.84183528	0.84183528	0.86	0.3687

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	4.40466463	4.40466463	4.48	0.0504

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.81110082	0.81110082	0.82	0.3773

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.13090494	0.13090494	0.13	0.7201

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LSE Log of Selenium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	76.24468393	2.45950593	2.48	0.0001
Error	214	212.07312215	0.99099590		
Corrected Total	245	288.31780608			

R-Square	C.V.	Root MSE	LSE Mean
0.264447	-17.25310	0.99548777	-5.76990689

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	17.10927626	1.14061842	1.15	0.3128
DATENUM(WELL)	16	59.13540767	3.69596298	3.73	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	8.41666573	0.56111105	0.57	0.8985
DATENUM(WELL)	16	59.13540767	3.69596298	3.73	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	8.41666573	0.56111105	0.15	0.9997

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	0.06670847	0.06670847	0.02	0.8948

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.08861962	0.08861962	0.02	0.8789

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	1.44599922	1.44599922	0.39	0.5405

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.02569413	0.02569413	0.01	0.9346

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LSE Log of Selenium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.02569413	0.02569413	0.01	0.9346

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.12989814	0.12989814	0.04	0.8536

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.63900197	0.63900197	0.17	0.6831

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.09081676	0.09081676	0.02	0.8774

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	1.67218186	1.67218186	0.45	0.5108

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.33629412	0.33629412	0.09	0.7668

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.07560361	1.07560361	0.29	0.5970

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.08872104	0.08872104	0.02	0.8788

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.01080929	0.01080929	0.00	0.9575

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LSO4 Log of Sulfate

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	1007.76981481	32.50870370	36.11	0.0001
Error	214	192.65363119	0.90025061		
Corrected Total	245	1200.42344600			

R-Square	C.V.	Root MSE	LSO4 Mean
0.839512	30.16875	0.94881537	3.14502684

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	895.34179258	59.68945284	66.30	0.0001
DATENUM(WELL)	16	112.42802224	7.02675139	7.81	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	93.56482953	6.23765530	6.93	0.0001
DATENUM(WELL)	16	112.42802224	7.02675139	7.81	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	93.56482953	6.23765530	0.89	0.5890

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	0.26160925	0.26160925	0.04	0.8494

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	4.59140208	4.59140208	0.65	0.4307

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	46.20457686	46.20457686	6.58	0.0208

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.04837294	0.04837294	0.01	0.9349

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LSO4 Log of Sulfate

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.35922852	0.35922852	0.05	0.8240

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	1.45729664	1.45729664	0.21	0.6549

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	4.06854168	4.06854168	0.58	0.4578

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.00052157	0.00052157	0.00	0.9932

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	44.93760929	44.93760929	6.40	0.0223

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.80876707	0.80876707	0.12	0.7388

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.28051311	1.28051311	0.18	0.6751

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	9.17147259	9.17147259	1.31	0.2701

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.37926200	0.37926200	0.05	0.8192

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LBA Log of Barium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	90.03383509	2.90431726	2.97	0.0001
Error	196	191.58724414	0.97748594		
Corrected Total	227	281.62107923			

R-Square	C.V.	Root MSE	LBA Mean
0.319698	-45.08950	0.98867889	-2.19270290

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	73.91397341	4.92759823	5.04	0.0001
DATENUM(WELL)	16	16.11986168	1.00749135	1.03	0.4260

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	14.47486368	0.96499091	0.99	0.4701
DATENUM(WELL)	16	16.11986168	1.00749135	1.03	0.4260

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	14.47486368	0.96499091	0.96	0.5310

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	2.11144976	2.11144976	2.10	0.1670

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.15783388	0.15783388	0.16	0.6975

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.94266699	0.94266699	0.94	0.3478

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.00699648	0.00699648	0.01	0.9346

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LBA Log of Barium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	2.07166589	2.07166589	2.06	0.1708

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.07388922	0.07388922	0.07	0.7900

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.87883841	0.87883841	0.87	0.3642

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	4.77905301	4.77905301	4.74	0.0447

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.42738088	0.42738088	0.42	0.5241

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.04738370	0.04738370	0.05	0.8311

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.95746662	0.95746662	0.95	0.3441

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	1.32217838	1.32217838	1.31	0.2688

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.25110536	0.25110536	0.25	0.6244

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCA Log of Calcium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	527.95204700	17.03071119	12.19	0.0001
Error	206	287.77328579	1.39695770		
Corrected Total	237	815.72533279			

R-Square	C.V.	Root MSE	LCA Mean
0.647218	87.86296	1.18192965	1.34519670

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	213.76972225	14.25131482	10.20	0.0001
DATENUM(WELL)	16	314.18232474	19.63639530	14.06	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	119.92101349	7.99473423	5.72	0.0001
DATENUM(WELL)	16	314.18232474	19.63639530	14.06	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	119.92101349	7.99473423	0.41	0.9553

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	70.54387388	70.54387388	3.59	0.0763

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.93059317	0.93059317	0.05	0.8304

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	14.37187222	14.37187222	0.73	0.4049

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	9.10985739	9.10985739	0.46	0.5055

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCA Log of Calcium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	2.79308830	2.79308830	0.14	0.7110

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	2.54622973	2.54622973	0.13	0.7235

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	11.53774079	11.53774079	0.59	0.4545

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.06138971	0.06138971	0.00	0.9561

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	22.90826947	22.90826947	1.17	0.2961

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.64704545	0.64704545	0.03	0.8582

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.92571523	0.92571523	0.05	0.8309

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	2.47749836	2.47749836	0.13	0.7271

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	1.21319547	1.21319547	0.06	0.8069

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNA Log of Sodium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	885.80513732	28.57435927	51.59	0.0001
Error	206	114.10846288	0.55392458		
Corrected Total	237	999.91360021			

R-Square	C.V.	Root MSE	LNA Mean
0.885882	29.77556	0.74426109	2.49957062

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	784.35365364	52.29024358	94.40	0.0001
DATENUM(WELL)	16	101.45148369	6.34071773	11.45	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	87.71265750	5.84751050	10.56	0.0001
DATENUM(WELL)	16	101.45148369	6.34071773	11.45	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	87.71265750	5.84751050	0.92	0.5601

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	2.00746180	2.00746180	0.32	0.5815

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.26313886	0.26313886	0.04	0.8411

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	29.32892357	29.32892357	4.63	0.0471

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.86981047	0.86981047	0.14	0.7160

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNA Log of Sodium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	2.28900351	2.28900351	0.36	0.5564

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.45957369	0.45957369	0.07	0.7912

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	2.70827048	2.70827048	0.43	0.5227

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.01002406	0.01002406	0.00	0.9688

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	35.67973859	35.67973859	5.63	0.0306

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.53774595	0.53774595	0.08	0.7746

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.13286173	0.13286173	0.02	0.8867

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.07608352	0.07608352	0.01	0.9141

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.84854351	0.84854351	0.13	0.7193

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNI Log of Nickel

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	166.61803576	5.37477535	5.37	0.0001
Error	206	206.01003052	1.00004869		
Corrected Total	237	372.62806628			

R-Square	C.V.	Root MSE	LNI Mean
0.447143	-27.70140	1.00002435	-3.61001338

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	142.04061174	9.46937412	9.47	0.0001
DATENUM(WELL)	16	24.57742402	1.53608900	1.54	0.0897

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	24.19275215	1.61285014	1.61	0.0725
DATENUM(WELL)	16	24.57742402	1.53608900	1.54	0.0897

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	24.19275215	1.61285014	1.05	0.4602

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.39159218	1.39159218	0.91	0.3554

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.13233678	0.13233678	0.09	0.7729

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.25470718	0.25470718	0.17	0.6893

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	8.31367095	8.31367095	5.41	0.0335

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNI Log of Nickel

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	4.34285665	4.34285665	2.83	0.1121

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	2.57409651	2.57409651	1.68	0.2139

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	1.55667066	1.55667066	1.01	0.3291

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.75664475	0.75664475	0.49	0.4929

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.35593840	0.35593840	0.23	0.6368

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	1.19179860	1.19179860	0.78	0.3914

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.26365453	1.26365453	0.82	0.3779

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.21839563	0.21839563	0.14	0.7111

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.08813509	0.08813509	0.06	0.8137

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCD Log of Cadmium

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	34.29210322	1.10619688	1.47	0.0612
Error	207	155.78094574	0.75256496		
Corrected Total	238	190.07304896			

R-Square	C.V.	Root MSE	LCD Mean
0.180415	-15.19078	0.86750502	-5.71073215

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	29.26550544	1.95103370	2.59	0.0014
DATENUM(WELL)	16	5.02659778	0.31416236	0.42	0.9770

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	4.46943425	0.29796228	0.40	0.9791
DATENUM(WELL)	16	5.02659778	0.31416236	0.42	0.9770

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	4.46943425	0.29796228	0.95	0.5386

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	0.21599049	0.21599049	0.69	0.4192

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.65541432	0.65541432	2.09	0.1679

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.01658532	0.01658532	0.05	0.8212

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.12480859	0.12480859	0.40	0.5374

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCD Log of Cadmium

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.23075395	0.23075395	0.73	0.4041

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.71225767	0.71225767	2.27	0.1516

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.38167548	0.38167548	1.21	0.2867

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.97159068	0.97159068	3.09	0.0978

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.56382835	0.56382835	1.79	0.1991

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.00016932	0.00016932	0.00	0.9818

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.02098936	0.02098936	0.07	0.7993

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.11557327	0.11557327	0.37	0.5527

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.02163903	0.02163903	0.07	0.7963

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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LMN Log of Manganese

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	755.00328560	24.35494470	12.22	0.0001
Error	203	404.42277120	1.99223040		
Corrected Total	234	1159.42605680			

R-Square	C.V.	Root MSE	LMN Mean
0.651187	-91.57499	1.41146392	-1.54132025

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	622.23956451	41.48263763	20.82	0.0001
DATENUM(WELL)	16	132.76372110	8.29773257	4.17	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	87.48237453	5.83215830	2.93	0.0003
DATENUM(WELL)	16	132.76372110	8.29773257	4.17	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	87.48237453	5.83215830	0.70	0.7499

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.41773835	1.41773835	0.17	0.6848

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.56336228	0.56336228	0.07	0.7978

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	2.11081402	2.11081402	0.25	0.6209

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	8.20862444	8.20862444	0.99	0.3347

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LMN Log of Manganese

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	13.99955545	13.99955545	1.69	0.2124

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	4.74296516	4.74296516	0.57	0.4606

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	20.02410436	20.02410436	2.41	0.1399

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	1.38882485	1.38882485	0.17	0.6879

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	9.54966214	9.54966214	1.15	0.2993

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	3.33143723	3.33143723	0.40	0.5353

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	2.26613044	2.26613044	0.27	0.6084

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	6.21586583	6.21586583	0.75	0.3996

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.30797000	0.30797000	0.04	0.8497

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LPB Log of Lead

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	76.63533929	2.47210772	0.69	0.8952
Error	212	764.88096191	3.60792907		
Corrected Total	243	841.51630121			

R-Square	C.V.	Root MSE	LPB Mean
0.091068	-51.00859	1.89945494	-3.72379408

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	39.81276611	2.65418441	0.74	0.7467
DATENUM(WELL)	16	36.82257318	2.30141082	0.64	0.8509

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	18.35972128	1.22398142	0.34	0.9905
DATENUM(WELL)	16	36.82257318	2.30141082	0.64	0.8509

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	18.35972128	1.22398142	0.53	0.8855

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	2.35927699	2.35927699	1.03	0.3264

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.00230430	0.00230430	0.00	0.9751

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	2.37063589	2.37063589	1.03	0.3252

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	1.12769269	1.12769269	0.49	0.4940

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LPB Log of Lead

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	1.76193172	1.76193172	0.77	0.3945

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.27301909	0.27301909	0.12	0.7350

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	0.20828124	0.20828124	0.09	0.7674

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	2.35459868	2.35459868	1.02	0.3268

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.01543551	0.01543551	0.01	0.9357

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	3.18511536	3.18511536	1.38	0.2566

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.04620031	0.04620031	0.02	0.8891

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	1.85709212	1.85709212	0.81	0.3823

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	1.83547405	1.83547405	0.80	0.3851

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCL Log of Chloride

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	724.85303613	23.38235600	30.98	0.0001
Error	215	162.28608704	0.75481901		
Corrected Total	246	887.13912317			

R-Square	C.V.	Root MSE	LCL Mean
0.817068	45.05236	0.86880321	1.92843004

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	615.17675866	41.01178391	54.33	0.0001
DATENUM(WELL)	16	109.67627748	6.85476734	9.08	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	84.30658605	5.62043907	7.45	0.0001
DATENUM(WELL)	16	109.67627748	6.85476734	9.08	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	84.30658605	5.62043907	0.82	0.6473

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.57149200	1.57149200	0.23	0.6386

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.06903445	0.06903445	0.01	0.9213

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	15.09540698	15.09540698	2.20	0.1572

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.10767149	0.10767149	0.02	0.9018

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LCL Log of Chloride

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	1.31820527	1.31820527	0.19	0.6669

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	0.01857642	0.01857642	0.00	0.9591

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	2.06473687	2.06473687	0.30	0.5907

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.32830786	0.32830786	0.05	0.8295

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	48.39305213	48.39305213	7.06	0.0172

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	1.21325567	1.21325567	0.18	0.6796

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.45654262	1.45654262	0.21	0.6510

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	3.85537606	3.85537606	0.56	0.4642

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	1.75726638	1.75726638	0.26	0.6195

Champion International
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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LF Log of Fluoride

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	260.95464224	8.41789169	8.24	0.0001
Error	214	218.75126351	1.02220217		
Corrected Total	245	479.70590575			

R-Square	C.V.	Root MSE	LF Mean
0.543989	-53.16939	1.01104014	-1.90154564

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	237.80779289	15.85385286	15.51	0.0001
DATENUM(WELL)	16	23.14684936	1.44667808	1.42	0.1363

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	23.66790718	1.57786048	1.54	0.0920
DATENUM(WELL)	16	23.14684936	1.44667808	1.42	0.1363

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	23.66790718	1.57786048	1.09	0.4311

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	4.35407986	4.35407986	3.01	0.1020

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.20368275	0.20368275	0.14	0.7124

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.85917774	0.85917774	0.59	0.4521

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	1.90294265	1.90294265	1.32	0.2683

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LF Log of Fluoride

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	1.92431953	1.92431953	1.33	0.2657

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	1.90191540	1.90191540	1.31	0.2684

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	4.58221570	4.58221570	3.17	0.0941

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.04051820	0.04051820	0.03	0.8692

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.55291664	0.55291664	0.38	0.5451

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.22778997	0.22778997	0.16	0.6968

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.25758516	0.25758516	0.18	0.6787

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.03778090	0.03778090	0.03	0.8736

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	2.38165190	2.38165190	1.65	0.2177

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNO2 Log of Nitrite

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	37.29442255	1.20304589	0.37	0.9991
Error	191	616.21747387	3.22626950		
Corrected Total	222	653.51189642			

R-Square	C.V.	Root MSE	LNO2 Mean
0.057068	-40.56174	1.79618192	-4.42826643

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	18.30851190	1.22056746	0.38	0.9832
DATENUM(WELL)	16	18.98591066	1.18661942	0.37	0.9880

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	14.99513891	0.99967593	0.31	0.9941
DATENUM(WELL)	16	18.98591066	1.18661942	0.37	0.9880

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	14.99513891	0.99967593	0.84	0.6277

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	1.20292823	1.20292823	1.01	0.3290

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.00790104	0.00790104	0.01	0.9360

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	0.03357172	0.03357172	0.03	0.8685

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	0.24004504	0.24004504	0.20	0.6589

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Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LNO2 Log of Nitrite

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	3.63723453	3.63723453	3.07	0.0991

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	1.23715954	1.23715954	1.04	0.3224

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	4.13292220	4.13292220	3.48	0.0804

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.33644132	0.33644132	0.28	0.6017

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.35835624	0.35835624	0.30	0.5902

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.44216901	0.44216901	0.37	0.5501

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.25731752	0.25731752	0.22	0.6477

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	0.54410245	0.54410245	0.46	0.5080

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.00388648	0.00388648	0.00	0.9551

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Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LPHEN Log of Total Phenols

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	343.86399476	11.09238693	2.44	0.0001
Error	211	960.05335831	4.55001592		
Corrected Total	242	1303.91735307			

R-Square	C.V.	Root MSE	LPHEN Mean
0.263716	-53.63243	2.13307663	-3.97721431

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	68.76242507	4.58416167	1.01	0.4485
DATENUM(WELL)	16	275.10156969	17.19384811	3.78	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	187.36027752	12.49068517	2.75	0.0007
DATENUM(WELL)	16	275.10156969	17.19384811	3.78	0.0001

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	187.36027752	12.49068517	0.73	0.7293

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	10.82485861	10.82485861	0.63	0.4391

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.21841896	0.21841896	0.01	0.9117

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	15.27620887	15.27620887	0.89	0.3599

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	43.82987149	43.82987149	2.55	0.1299

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LPHEN Log of Total Phenols

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	30.17586842	30.17586842	1.76	0.2039

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	34.63560762	34.63560762	2.01	0.1750

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	12.16056550	12.16056550	0.71	0.4127

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	5.05303337	5.05303337	0.29	0.5952

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	0.71810798	0.71810798	0.04	0.8406

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	5.15171792	5.15171792	0.30	0.5917

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.02605069	0.02605069	0.00	0.9694

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	18.74754070	18.74754070	1.09	0.3119

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.23317277	0.23317277	0.01	0.9087

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LTOC Log of Total Organic Carbon

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	398.24062260	12.84647170	6.73	0.0001
Error	213	406.77645941	1.90974864		
Corrected Total	244	805.01708201			

R-Square	C.V.	Root MSE	LTOC Mean
0.494698	104.3863	1.38193655	1.32386736

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	371.11954018	24.74130268	12.96	0.0001
DATENUM(WELL)	16	27.12108241	1.69506765	0.89	0.5842

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	23.61001413	1.57400094	0.82	0.6501
DATENUM(WELL)	16	27.12108241	1.69506765	0.89	0.5842

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	23.61001413	1.57400094	0.93	0.5548

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	2.13929136	2.13929136	1.26	0.2778

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.45557485	0.45557485	0.27	0.6113

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	4.75731489	4.75731489	2.81	0.1133

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	1.03531932	1.03531932	0.61	0.4459

Champion International
Canton Landfill No. 6
Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LTOC Log of Total Organic Carbon

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	0.33193815	0.33193815	0.20	0.6640

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	3.08230689	3.08230689	1.82	0.1963

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	2.10694030	2.10694030	1.24	0.2814

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	2.70677888	2.70677888	1.60	0.2245

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	2.73281813	2.73281813	1.61	0.2223

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	0.00493323	0.00493323	0.00	0.9576

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	1.82705531	1.82705531	1.08	0.3146

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	1.53882340	1.53882340	0.91	0.3549

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.25017307	0.25017307	0.15	0.7059

Champion International
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Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LTOH Log of Total Organic Halogens

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	306.66517515	9.89242500	4.34	0.0001
Error	185	422.08539451	2.28154267		
Corrected Total	216	728.75056966			

R-Square	C.V.	Root MSE	LTOH Mean
0.420810	-45.26459	1.51047763	-3.33699636

Source	DF	Type I SS	Mean Square	F Value	Pr > F
WELL	15	240.54131884	16.03608792	7.03	0.0001
DATENUM(WELL)	16	66.12385631	4.13274102	1.81	0.0323

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	38.36439132	2.55762609	1.12	0.3401
DATENUM(WELL)	16	66.12385631	4.13274102	1.81	0.0323

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
WELL	15	38.36439132	2.55762609	0.62	0.8204

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1 vs Bkg & time	1	5.67435552	5.67435552	1.37	0.2584

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-12 vs Bkg & time	1	0.15651565	0.15651565	0.04	0.8481

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-13 vs Bkg & time	1	4.37230672	4.37230672	1.06	0.3190

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-14 vs Bkg & time	1	4.61212951	4.61212951	1.12	0.3065

Champion International
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Canton, North Carolina

Analysis of Variance for

General Linear Models Procedure

Dependent Variable: LTOH Log of Total Organic Halogens

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-15 vs Bkg & time	1	2.91069792	2.91069792	0.70	0.4137

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-1A vs Bkg & time	1	1.20468272	1.20468272	0.29	0.5967

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-2 vs Bkg & time	1	5.18251106	5.18251106	1.25	0.2793

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-3A vs Bkg & time	1	0.56241911	0.56241911	0.14	0.7170

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-4 vs Bkg & time	1	6.19047845	6.19047845	1.50	0.2387

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-5A vs Bkg & time	1	5.72043994	5.72043994	1.38	0.2566

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-6 vs Bkg & time	1	0.23497199	0.23497199	0.06	0.8146

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-7A vs Bkg & time	1	2.61773207	2.61773207	0.63	0.4378

Tests of Hypotheses using the Type III MS for DATENUM(WELL) as an error term

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
MW-8 vs Bkg & time	1	0.00231053	0.00231053	0.00	0.9814

Champion International
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Evaluation of the Assumptions for the
Analysis of Variance

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	245	Sum Wgts	245
Mean	0	Sum	0
Std Dev	0.603719	Variance	0.364476
Skewness	0.35385	Kurtosis	3.799928
USS	88.9322	CSS	88.9322
CV	.	Std Mean	0.03857
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-848.5	Prob>|S|	0.4459
Num ^= 0	245		
W:Normal	0.962895	Prob<W	0.0002

Quantiles(Def=5)

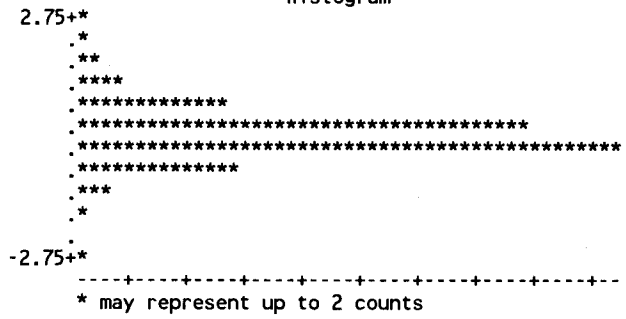
100% Max	2.630821	99%	1.841487
75% Q3	0.285779	95%	1.005502
50% Med	-0.04229	90%	0.624326
25% Q1	-0.37478	10%	-0.58817
0% Min	-2.82633	5%	-0.79174
		1%	-1.32473
Range	5.45715		
Q3-Q1	0.660556		
Mode	-2.82633		

Extremes

Lowest	Obs	Highest	Obs
-2.82633(	111)	1.657478(	1)
-1.85196(	112)	1.709723(	68)
-1.32473(	144)	1.841487(	47)
-1.31228(	110)	2.11893(	114)
-1.26667(	122)	2.630821(	113)

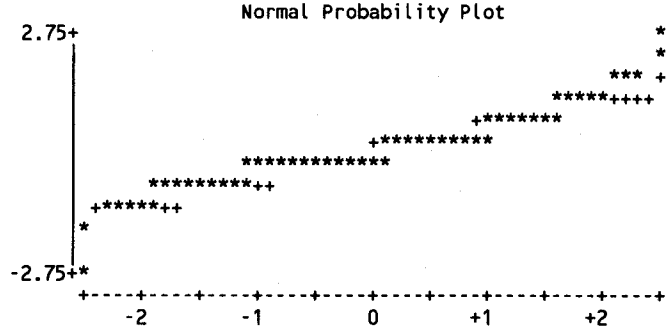
Missing Value	.
Count	3
% Count/Nobs	1.21

Histogram



#	Boxplot
1	*
1	0
3	0
8	0
26	|
78	+--+--+
94	*-----*
27	|
5	|
1	0
1	*

Normal Probability Plot



Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-1 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	13	Sum Wgts	13
Mean	0	Sum	0
Std Dev	0.890829	Variance	0.793576
Skewness	0.61033	Kurtosis	-0.9195
USS	9.522908	CSS	9.522908
CV	.	Std Mean	0.247071
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-1.5	Prob>|S|	0.9460
Num ^= 0	13		
W:Normal	0.905423	Prob<W	0.1544

Quantiles(Def=5)

100% Max	1.657478	99%	1.657478
75% Q3	0.983396	95%	1.657478
50% Med	-0.3648	90%	1.03789
25% Q1	-0.54191	10%	-1.02829
0% Min	-1.07986	5%	-1.07986
		1%	-1.07986
Range	2.737336		
Q3-Q1	1.525308		
Mode	-1.07986		

Extremes

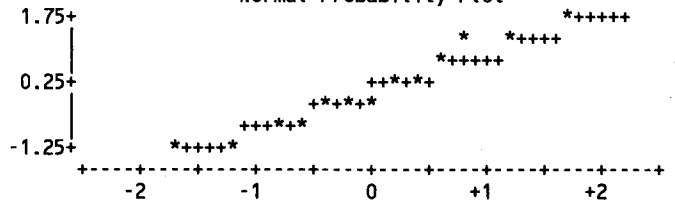
Lowest	Obs	Highest	Obs
-1.07986(	5)	0.051772(	3)
-1.02829(	6)	0.983396(	11)
-0.79174(	10)	1.005502(	12)
-0.54191(	9)	1.03789(	13)
-0.49464(	8)	1.657478(	1)

Stem Leaf #

```
   1 7          1
   1 000        3
   0
   0 01         2
  -0 44         2
  -0 855        3
  -1 10         2
     ----+----+----+----+
```

Boxplot

Normal Probability Plot



Champion International
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Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-10 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	20	Sum Wgts	20
Mean	0	Sum	0
Std Dev	0.387206	Variance	0.149929
Skewness	0.365825	Kurtosis	0.005865
USS	2.848642	CSS	2.848642
CV	.	Std Mean	0.086582
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-2	Prob>|S|	0.9563
Num ^= 0	20		
W:Normal	0.962308	Prob<W	0.5931

Quantiles(Def=5)

100% Max	0.899856	99%	0.899856
75% Q3	0.206235	95%	0.707707
50% Med	0.059241	90%	0.485998
25% Q1	-0.35199	10%	-0.49832
0% Min	-0.58817	5%	-0.56334
		1%	-0.58817
Range	1.488023		
Q3-Q1	0.558221		
Mode	-0.58817		

Extremes

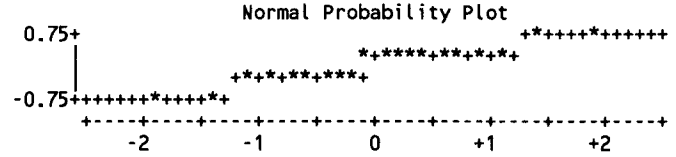
Lowest	Obs	Highest	Obs
-0.58817(	6)	0.231825(	9)
-0.53851(	12)	0.26789(	16)
-0.45813(	5)	0.456437(	13)
-0.43732(	8)	0.515559(	11)
-0.41875(	7)	0.899856(	1)

Missing Value	.
Count	1
% Count/Nobs	4.76

```
Stem Leaf                     #
   0 559                      3
   0 11112223                 8
  -0 443210                   6
  -0 655                      3
     ----+----+----+----+
```

Boxplot

Normal Probability Plot



Champion International
Canton Landfill No. 6
Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-11 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	20	Sum Wgts	20
Mean	0	Sum	0
Std Dev	0.636556	Variance	0.405204
Skewness	1.448006	Kurtosis	2.633329
USS	7.698877	CSS	7.698877
CV	.	Std Mean	0.142338
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-20	Prob>|S|	0.4749
Num ^= 0	20		
W:Normal	0.883531	Prob<W	0.0201

Quantiles(Def=5)

100% Max	1.841487	99%	1.841487
75% Q3	0.147974	95%	1.44721
50% Med	-0.09341	90%	0.83863
25% Q1	-0.38848	10%	-0.69196
0% Min	-0.80412	5%	-0.75079
		1%	-0.80412
Range	2.64561		
Q3-Q1	0.53645		
Mode	-0.80412		

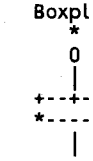
Extremes

Lowest	Obs	Highest	Obs
-0.80412(	8)	0.165933(	19)
-0.69745(	7)	0.607097(	11)
-0.68647(	6)	0.624326(	5)
-0.51233(	12)	1.052933(	1)
-0.41521(	9)	1.841487(	13)

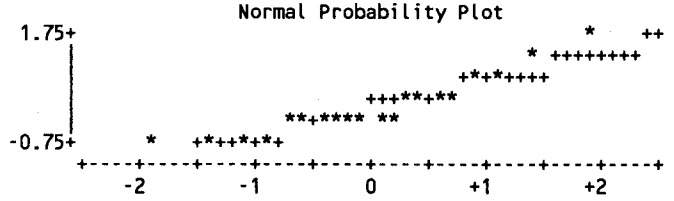
Stem Leaf #

```
   1 8          1
   1 1          1
   0 66         2
   0 0012       4
  -0 44331111   8
  -0 8775       4
     ----+----+----+----+
```

Boxplot



Normal Probability Plot



Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-12 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	21	Sum Wgts	21
Mean	0	Sum	0
Std Dev	0.589105	Variance	0.347044
Skewness	1.647804	Kurtosis	2.533674
USS	6.940888	CSS	6.940888
CV	.	Std Mean	0.128553
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-25.5	Prob>|S|	0.3885
Num ^= 0	21		
W:Normal	0.813462	Prob<W	0.0007

Quantiles(Def=5)

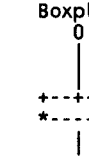
100% Max	1.709723	99%	1.709723
75% Q3	0.216265	95%	1.104965
50% Med	-0.23798	90%	0.756973
25% Q1	-0.41499	10%	-0.45385
0% Min	-0.58396	5%	-0.48078
		1%	-0.58396
Range	2.293684		
Q3-Q1	0.631254		
Mode	-0.58396		

Extremes

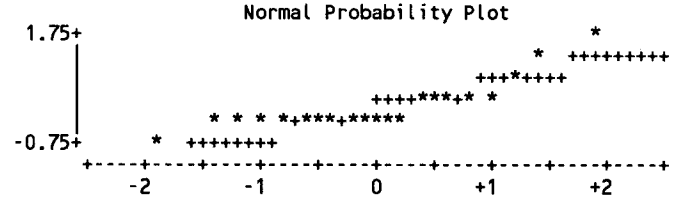
Lowest	Obs	Highest	Obs
-0.58396(	6)	0.337761(	9)
-0.48078(	2)	0.419076(	12)
-0.45385(	5)	0.756973(	11)
-0.42392(	8)	1.104965(	1)
-0.41972(	10)	1.709723(	14)

```
Stem Leaf                     #
   1 7                        1
   1 1                        1
   0 8                        1
   0 11234                    5
  -0 4444333221              10
  -0 655                      3
     ----+----+----+----+
```

Boxplot



Normal Probability Plot



Champion International
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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-13 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	13	Sum Wgts	13
Mean	0	Sum	0
Std Dev	0.549732	Variance	0.302205
Skewness	1.438254	Kurtosis	2.441242
USS	3.62646	CSS	3.62646
CV	.	Std Mean	0.152468
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-3.5	Prob>|S|	0.8394
Num ^= 0	13		
W:Normal	0.854815	Prob<W	0.0316

Quantiles(Def=5)

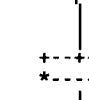
100% Max	1.401013	99%	1.401013
75% Q3	0.371853	95%	1.401013
50% Med	-0.24678	90%	0.454308
25% Q1	-0.36784	10%	-0.39491
0% Min	-0.66719	5%	-0.66719
		1%	-0.66719
Range	2.068205		
Q3-Q1	0.739697		
Mode	-0.66719		

Extremes

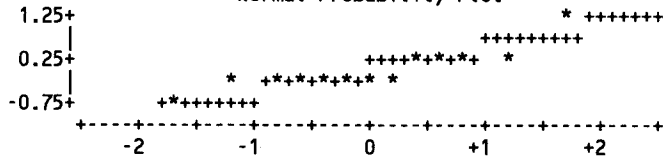
Lowest	Obs	Highest	Obs
-0.66719(	5)	0.182961(	4)
-0.39491(	10)	0.371853(	13)
-0.37977(	7)	0.385349(	1)
-0.36784(	2)	0.454308(	11)
-0.30474(	8)	1.401013(	6)

```
Stem Leaf                     #          Boxplot
   1 4                        1             |
   0 5                        1             |
   0 244                      3          +--+--+
  -0 4443322                  7          *-----*
  -0 7                        1             |
     ----+----+----+----+
```

Normal Probability Plot



```
1.25+                                                  * +++++++
    |                                                +++++++++
0.25+                                  ++++*+*+*+  *
    |                        *  +*+*+*+*+* *
-0.75+                +*+++++++
     +----+----+----+----+----+----+----+----+----+----+
         -2        -1         0        +1        +2
```



Evaluation of the Assumptions for the
Analysis of Variance

WELL=MW-14

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	7	Sum Wgts	7
Mean	0	Sum	0
Std Dev	0.404477	Variance	0.163602
Skewness	-0.13055	Kurtosis	-1.83778
USS	0.981611	CSS	0.981611
CV	.	Std Mean	0.152878
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-1	Prob>|S|	0.9375
Num ^= 0	7		
W:Normal	0.906037	Prob<W	0.3840

Quantiles(Def=5)

100% Max	0.461601	99%	0.461601
75% Q3	0.43485	95%	0.461601
50% Med	-0.03893	90%	0.461601
25% Q1	-0.43915	10%	-0.53082
0% Min	-0.53082	5%	-0.53082
		1%	-0.53082
Range	0.992424		
Q3-Q1	0.874		
Mode	-0.53082		

Extremes

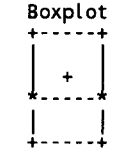
Lowest	Obs	Highest	Obs
-0.53082(	4)	-0.16397(	3)
-0.43915(	6)	-0.03893(	1)
-0.16397(	3)	0.276427(	5)
-0.03893(	1)	0.43485(	7)
0.276427(	5)	0.461601(	2)

Stem Leaf #

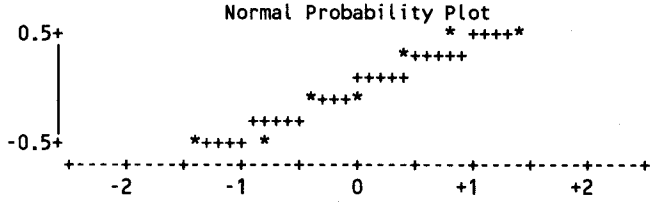
```
   4 36      2
   2 8       1
   0
  -0 64      2
  -2
  -4 34      2
     ----+----+----+----+
```

Multiply Stem.Leaf by 10**-1

Boxplot



Normal Probability Plot



Champion International
Canton Landfill No. 6
Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-15 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	7	Sum Wgts	7
Mean	0	Sum	0
Std Dev	0.284071	Variance	0.080696
Skewness	-0.72488	Kurtosis	-0.2749
USS	0.484178	CSS	0.484178
CV	.	Std Mean	0.107369
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	0	Prob>|S|	1.0000
Num ^= 0	7		
W:Normal	0.927071	Prob<W	0.5447

Quantiles(Def=5)

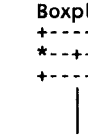
100% Max	0.334759	99%	0.334759
75% Q3	0.206263	95%	0.334759
50% Med	0.134875	90%	0.334759
25% Q1	-0.18667	10%	-0.48359
0% Min	-0.48359	5%	-0.48359
		1%	-0.48359
Range	0.81835		
Q3-Q1	0.39293		
Mode	-0.48359		

Extremes

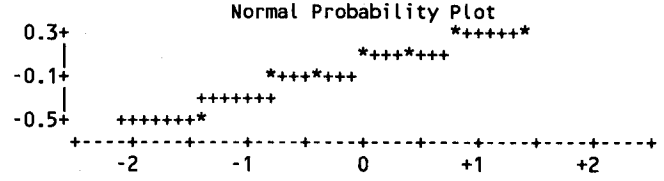
Lowest	Obs	Highest	Obs
-0.48359(	6)	-0.14886(	4)
-0.18667(	1)	0.134875(	3)
-0.14886(	4)	0.143225(	2)
0.134875(	3)	0.206263(	7)
0.143225(	2)	0.334759(	5)

```
Stem Leaf                     #
   2 13                       2
   0 34                       2
  -0 95                       2
  -2                          
  -4 8                        1
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



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Evaluation of the Assumptions for the
Analysis of Variance

WELL=MW-1A

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	7	Sum Wgts	7
Mean	0	Sum	0
Std Dev	0.179791	Variance	0.032325
Skewness	2.201975	Kurtosis	5.137458
USS	0.193948	CSS	0.193948
CV	.	Std Mean	0.067955
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-4	Prob>|S|	0.5781
Num ^= 0	7		
W:Normal	0.699335	Prob<W	0.0036

Quantiles(Def=5)

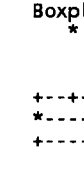
100% Max	0.389915	99%	0.389915
75% Q3	0.008927	95%	0.389915
50% Med	-0.07512	90%	0.389915
25% Q1	-0.11449	10%	-0.1173
0% Min	-0.1173	5%	-0.1173
		1%	-0.1173
Range	0.507217		
Q3-Q1	0.123412		
Mode	-0.1173		

Extremes

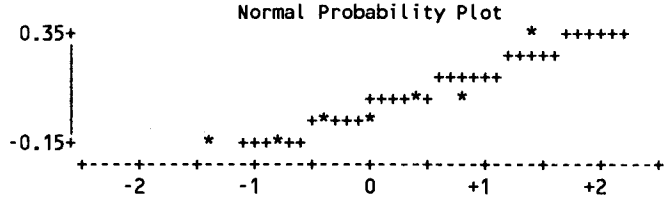
Lowest	Obs	Highest	Obs
-0.1173(	7)	-0.09646(	1)
-0.11449(	6)	-0.07512(	4)
-0.09646(	1)	0.004526(	3)
-0.07512(	4)	0.008927(	2)
0.004526(	3)	0.389915(	5)

```
Stem Leaf                     #
   3 9                        1
   2                          
   1                          
   0 01                       2
  -0 8                        1
  -1 210                      3
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



Champion International
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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-2 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	20	Sum Wgts	20
Mean	0	Sum	0
Std Dev	1.308088	Variance	1.711095
Skewness	-0.05133	Kurtosis	0.31766
USS	32.5108	CSS	32.5108
CV	.	Std Mean	0.292497
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	5	Prob>|S|	0.8695
Num ^= 0	20		
W:Normal	0.983538	Prob<W	0.9582

Quantiles(Def=5)

100% Max	2.630821	99%	2.630821
75% Q3	0.702092	95%	2.374876
50% Med	0.160031	90%	1.707653
25% Q1	-0.842	10%	-1.58212
0% Min	-2.82633	5%	-2.33914
		1%	-2.82633
Range	5.45715		
Q3-Q1	1.544096		
Mode	-2.82633		

Extremes

Lowest	Obs	Highest	Obs
-2.82633(	2)	0.73774(	9)
-1.85196(	3)	1.273414(	7)
-1.31228(	1)	1.296377(	6)
-1.26667(	13)	2.11893(	5)
-0.89351(	15)	2.630821(	4)

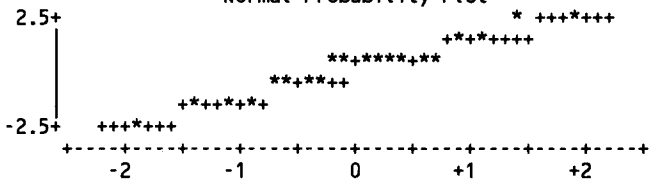
Missing Value	.
Count	1
% Count/Nobs	4.76

Stem	Leaf	#
2	16	2
1	33	2
0	01222377	8
-0	9862	4
-1	933	3
-2	8	1

----+----+----+----+

Boxplot

Normal Probability Plot



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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-3A ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	12	Sum Wgts	12
Mean	0	Sum	0
Std Dev	0.573304	Variance	0.328677
Skewness	1.470452	Kurtosis	3.26069
USS	3.61545	CSS	3.61545
CV	.	Std Mean	0.165499
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-8	Prob>|S|	0.5693
Num ^= 0	12		
W:Normal	0.881128	Prob<W	0.0865

Quantiles(Def=5)

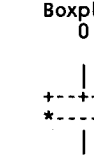
100% Max	1.451241	99%	1.451241
75% Q3	0.141475	95%	1.451241
50% Med	-0.09891	90%	0.544517
25% Q1	-0.3236	10%	-0.53285
0% Min	-0.77777	5%	-0.77777
		1%	-0.77777
Range	2.229011		
Q3-Q1	0.465071		
Mode	-0.77777		

Extremes

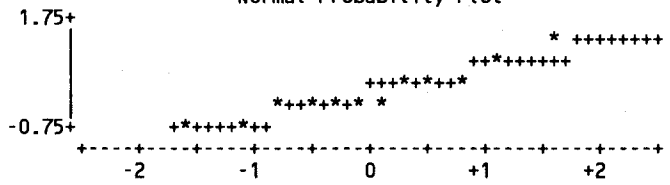
Lowest	Obs	Highest	Obs
-0.77777(	4)	0.007038(	9)
-0.53285(	5)	0.012247(	10)
-0.36908(	3)	0.270702(	12)
-0.27811(	11)	0.544517(	1)
-0.1301(	8)	1.451241(	6)

```
Stem Leaf                     #
   1 5                        1
   1
   0 5                        1
   0 003                      3
  -0 43111                    5
  -0 85                       2
     ----+----+----+----+
```

Boxplot



Normal Probability Plot



Champion International
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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-4 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	20	Sum Wgts	20
Mean	0	Sum	0
Std Dev	0.59505	Variance	0.354084
Skewness	-0.63022	Kurtosis	-0.16875
USS	6.727596	CSS	6.727596
CV	.	Std Mean	0.133057
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	7	Prob>|S|	0.8124
Num ^= 0	20		
W:Normal	0.952826	Prob<W	0.4225

Quantiles(Def=5)

100% Max	0.882298	99%	0.882298
75% Q3	0.406179	95%	0.853721
50% Med	0.069448	90%	0.716226
25% Q1	-0.42109	10%	-0.8735
0% Min	-1.32473	5%	-1.10981
		1%	-1.32473
Range	2.207024		
Q3-Q1	0.82727		
Mode	-1.32473		

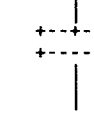
Extremes

Lowest	Obs	Highest	Obs
-1.32473(	2)	0.453339(	11)
-0.8949(	13)	0.522942(	18)
-0.8521(	5)	0.607307(	9)
-0.60181(	14)	0.825145(	7)
-0.5746(	12)	0.882298(	1)

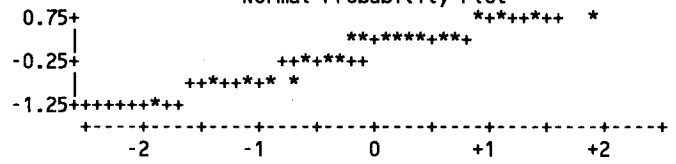
Missing Value	.
Count	1
% Count/Nobs	4.76

```
Stem Leaf                 #
   0 55689                5
   0 1113334              7
  -0 311                  3
  -0 9966                 4
  -1 3                    1
     ----+----+----+----+
```

Boxplot



Normal Probability Plot



Evaluation of the Assumptions for the
Analysis of Variance

WELL=MW-5A

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	13	Sum Wgts	13
Mean	0	Sum	0
Std Dev	0.383615	Variance	0.147161
Skewness	0.294251	Kurtosis	-1.26263
USS	1.765927	CSS	1.765927
CV	.	Std Mean	0.106396
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-2.5	Prob>|S|	0.8926
Num ^= 0	13		
W:Normal	0.927183	Prob<W	0.2991

Quantiles(Def=5)

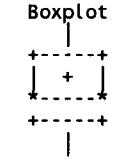
100% Max	0.581565	99%	0.581565
75% Q3	0.356698	95%	0.581565
50% Med	-0.10273	90%	0.573797
25% Q1	-0.22499	10%	-0.43881
0% Min	-0.52197	5%	-0.52197
		1%	-0.52197
Range	1.103531		
Q3-Q1	0.581687		
Mode	-0.52197		

Extremes

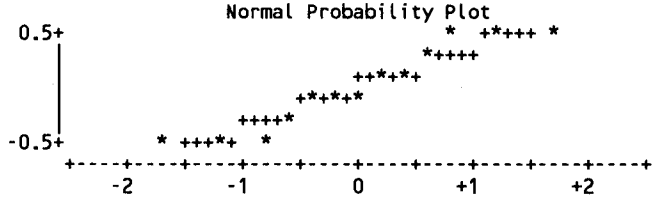
Lowest	Obs	Highest	Obs
-0.52197(	5)	0.093207(	9)
-0.43881(	2)	0.356698(	1)
-0.42995(	3)	0.410718(	11)
-0.22499(	7)	0.573797(	4)
-0.19541(	12)	0.581565(	6)

```
Stem Leaf                     #
   4 178                      3
   2 6                        1
   0 99                       2
  -0 90                       2
  -2 20                       2
  -4 243                      3
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



Champion International
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Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-6 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	21	Sum Wgts	21
Mean	0	Sum	0
Std Dev	0.3209	Variance	0.102977
Skewness	0.445129	Kurtosis	-0.67178
USS	2.059541	CSS	2.059541
CV	.	Std Mean	0.070026
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	-10.5	Prob>|S|	0.7246
Num ^= 0	21		
W:Normal	0.948664	Prob<W	0.3161

Quantiles(Def=5)

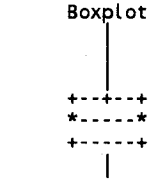
100% Max	0.613848	99%	0.613848
75% Q3	0.19042	95%	0.534427
50% Med	-0.0568	90%	0.435007
25% Q1	-0.24063	10%	-0.33493
0% Min	-0.55484	5%	-0.34106
		1%	-0.55484
Range	1.168689		
Q3-Q1	0.431051		
Mode	-0.55484		

Extremes

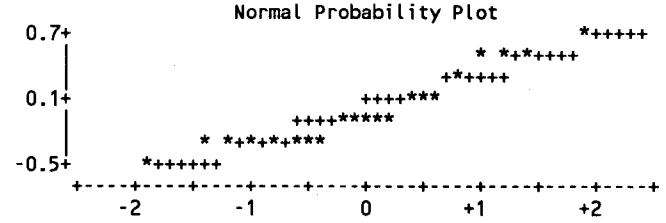
Lowest	Obs	Highest	Obs
-0.55484(	8)	0.310671(	9)
-0.34106(	10)	0.431169(	1)
-0.33493(	13)	0.435007(	16)
-0.28596(	21)	0.534427(	14)
-0.24647(	7)	0.613848(	12)

```
Stem Leaf                     #
   6 1                        1
   4 343                      3
   2 1                        1
   0 299                      3
  -0 97643                    5
  -2 4395432                  7
  -4 5                        1
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



Champion International
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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-7A ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	13	Sum Wgts	13
Mean	0	Sum	0
Std Dev	0.358115	Variance	0.128246
Skewness	-0.38227	Kurtosis	0.425553
USS	1.538957	CSS	1.538957
CV	.	Std Mean	0.099323
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	2.5	Prob>|S|	0.8926
Num ^= 0	13		
W:Normal	0.96282	Prob<W	0.7471

Quantiles(Def=5)

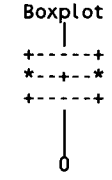
100% Max	0.543089	99%	0.543089
75% Q3	0.220978	95%	0.543089
50% Med	0.00713	90%	0.532033
25% Q1	-0.14032	10%	-0.46294
0% Min	-0.73897	5%	-0.73897
		1%	-0.73897
Range	1.282061		
Q3-Q1	0.361299		
Mode	-0.73897		

Extremes

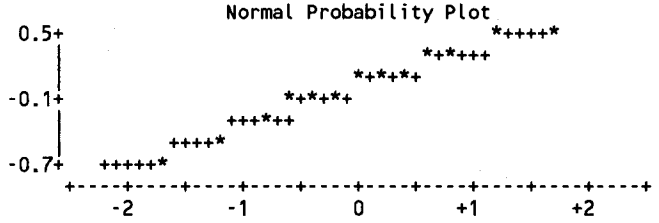
Lowest	Obs	Highest	Obs
-0.73897(	2)	0.115465(	9)
-0.46294(	5)	0.220978(	8)
-0.20074(	12)	0.238419(	3)
-0.14032(	10)	0.532033(	6)
-0.10634(	13)	0.543089(	4)

```
Stem Leaf                     #
   4 34                       2
   2 24                       2
   0 172                      3
  -0 418                      3
  -2 0                        1
  -4 6                        1
  -6 4                        1
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



Champion International
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Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-8 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	19	Sum Wgts	19
Mean	0	Sum	0
Std Dev	0.381589	Variance	0.14561
Skewness	0.382123	Kurtosis	-0.84856
USS	2.620983	CSS	2.620983
CV	.	Std Mean	0.087543
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	1	Prob>|S|	0.9843
Num ^= 0	19		
W:Normal	0.937309	Prob<W	0.2432

Quantiles(Def=5)

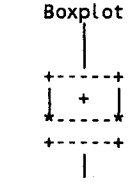
100% Max	0.741466	99%	0.741466
75% Q3	0.268107	95%	0.741466
50% Med	-0.01461	90%	0.595676
25% Q1	-0.37917	10%	-0.47477
0% Min	-0.48234	5%	-0.48234
		1%	-0.48234
Range	1.223811		
Q3-Q1	0.647276		
Mode	-0.48234		

Extremes

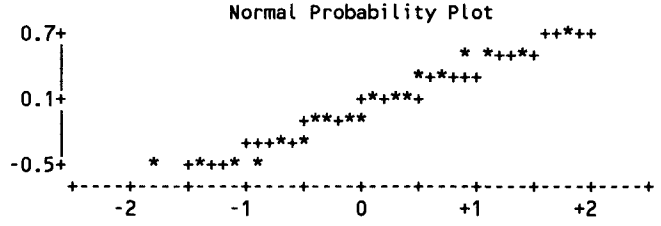
Lowest	Obs	Highest	Obs
-0.48234(	7)	0.268107(	17)
-0.47477(	11)	0.426529(	12)
-0.46206(	9)	0.487257(	1)
-0.4183(	5)	0.595676(	10)
-0.37917(	4)	0.741466(	3)

```
Stem Leaf                     #
   6 04                       2
   4 39                       2
   2 17                       2
   0 478                      3
  -0 8321                     4
  -2 86                       2
  -4 8762                     4
     ----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

Boxplot



Normal Probability Plot



Champion International
Canton Landfill No. 6
Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

---------- WELL=MW-9 ----------

UNIVARIATE PROCEDURE

Variable=RESIDUAL

Moments

N	19	Sum Wgts	19
Mean	0	Sum	0
Std Dev	0.567423	Variance	0.321968
Skewness	0.1156	Kurtosis	-1.49521
USS	5.795432	CSS	5.795432
CV	.	Std Mean	0.130176
T:Mean=0	0	Prob>|T|	1.0000
Sgn Rank	3	Prob>|S|	0.9217
Num ^= 0	19		
W:Normal	0.922394	Prob<W	0.1296

Quantiles(Def=5)

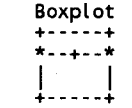
100% Max	0.880293	99%	0.880293
75% Q3	0.52739	95%	0.880293
50% Med	0.029317	90%	0.841997
25% Q1	-0.49028	10%	-0.72458
0% Min	-0.84204	5%	-0.84204
		1%	-0.84204
Range	1.722333		
Q3-Q1	1.017674		
Mode	-0.84204		

Extremes

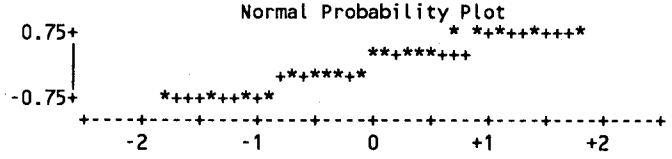
Lowest	Obs	Highest	Obs
-0.84204(	15)	0.52739(	13)
-0.72458(	11)	0.611145(	3)
-0.63758(	14)	0.64033(	19)
-0.59299(	5)	0.841997(	1)
-0.49028(	4)	0.880293(	10)

```
Stem Leaf                     #
   0 556689                   6
   0 0124                     4
  -0 4443                     4
  -0 87665                    5
     ----+----+----+----+
```

Boxplot



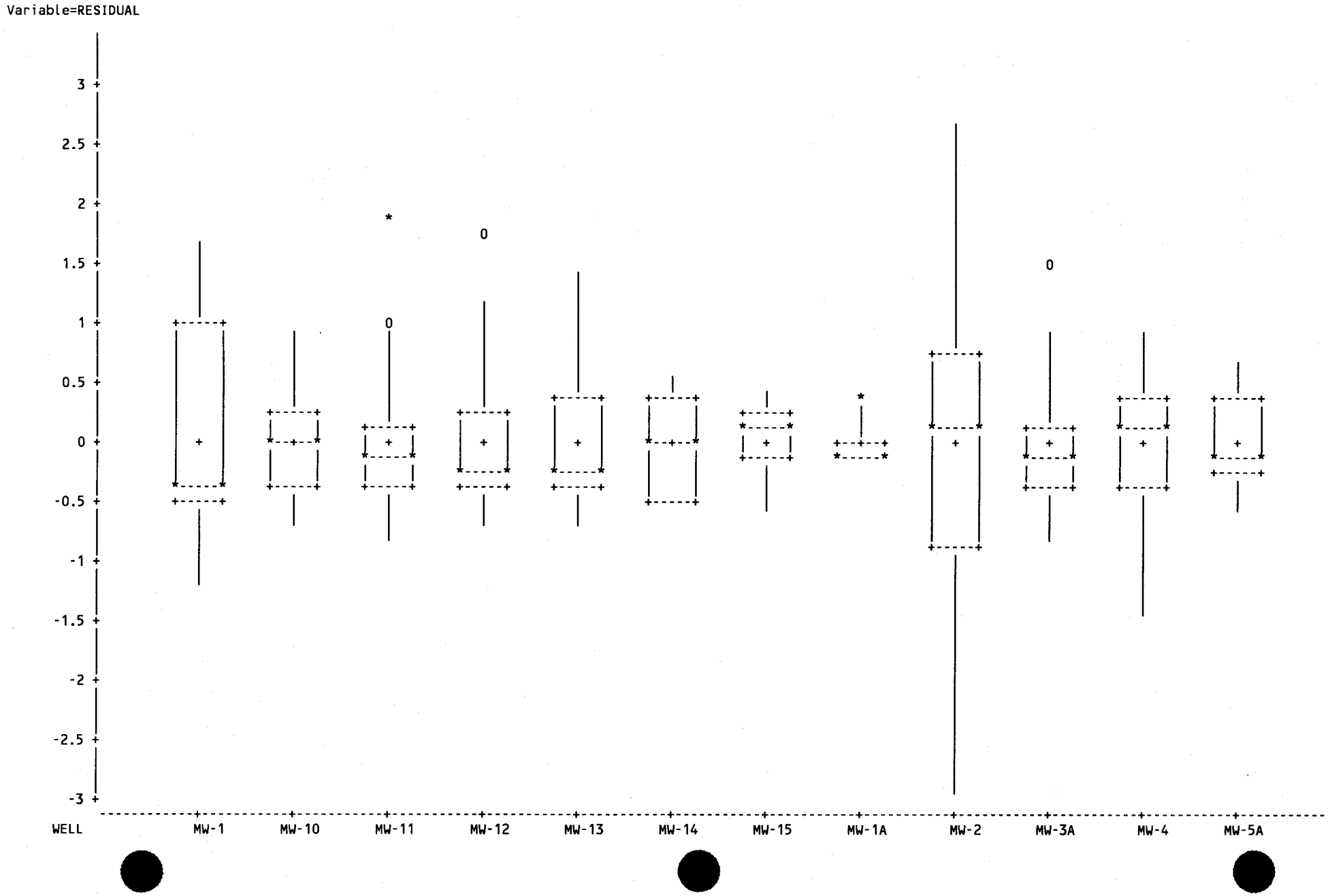
Normal Probability Plot



Champion International
Canton Landfill No. 6
Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

UNIVARIATE PROCEDURE
Schematic Plots

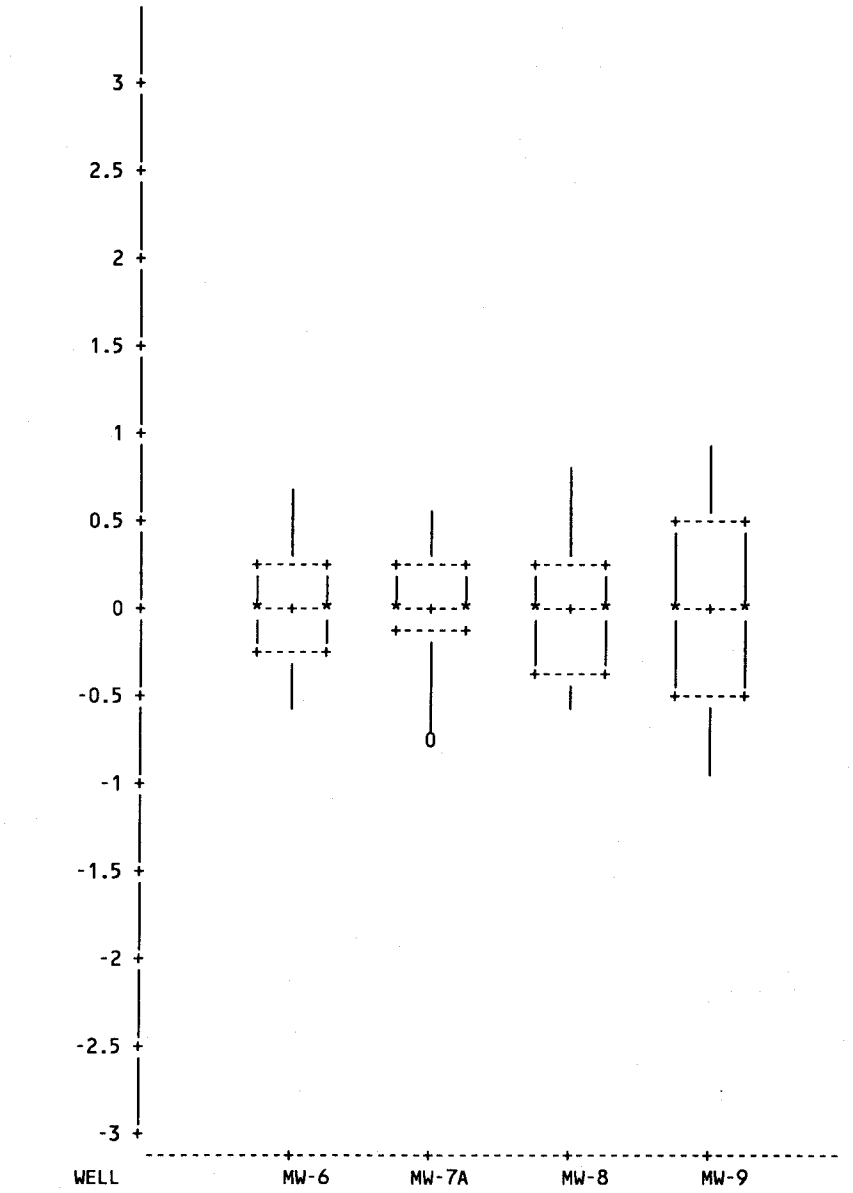


Champion International
Canton Landfill No. 6
Canton, North Carolina

Evaluation of the Assumptions for the
Analysis of Variance

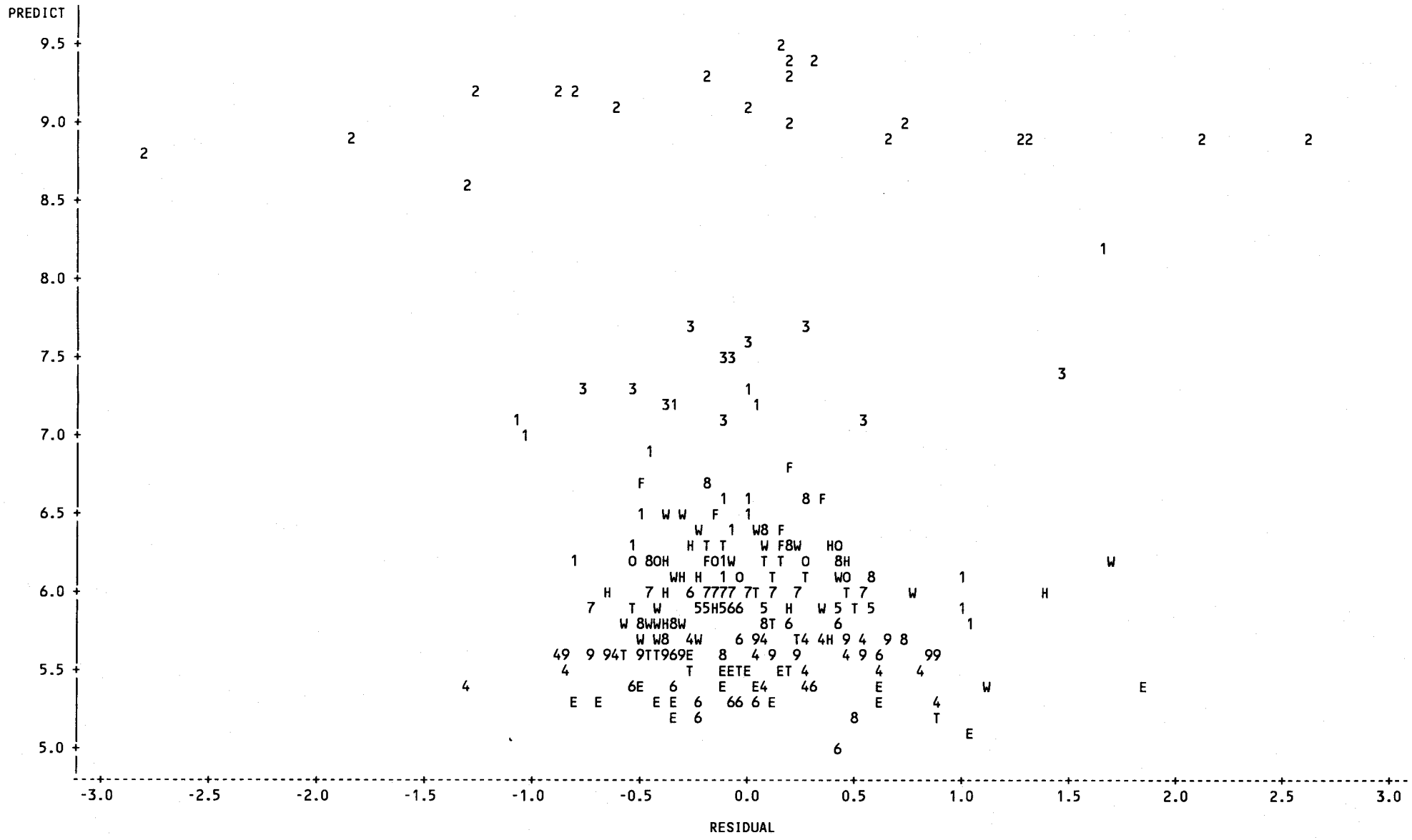
UNIVARIATE PROCEDURE
Schematic Plots

Variable=RESIDUAL



Evaluation of the Assumptions for the
Analysis of Variance

Plot of PREDICT*RESIDUAL. Symbol is value of CHAR.



NOTE: 3 obs had missing values. 32 obs hidden.

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-1

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	9.90	6.7	380	0.0050	0.0010	0.050	.	.0050	0.300	10.4	.00025	0.16
DEC86	7.30	13950.0	380	0.0300	0.0400	0.100	0.040	.	0.040	92.0	.00030	0.13
FEB87	7.30	12600.0	302	0.0160	0.0060	0.100	0.100	.	0.090	118.0	.00040	0.12
JUN87	6.80	5000.0	344	0.0250	0.0250	0.050	0.006	.0050	0.010	34.7	.00015	0.08
SEP87	6.00	316.0	182	0.0015	0.0025	0.100	1.400	.0025	0.010	3.2	.00015	0.04
NOV87	6.00	508.0	191	0.0050	0.0015	0.050	1.200	.0025	0.010	4.3	.00010	0.04
MAR88	6.50	304.0	135	0.0050	0.0025	0.050	0.690	.0025	0.010	1.3	.00050	0.02
NOV89	5.98	762.0	807	0.0050	0.0050	0.100	68.200	.0050	0.010	34.8	.00021	0.87
MAY90	5.80	290.0	390	0.0025	0.0025	0.043	23.900	.0070	0.004	14.6	.00010	.
DEC90	5.40	332.0	403	0.0050	0.0050	0.250	23.000	.0025	0.010	15.6	.00010	0.25
MAY91	7.05	1644.0	440	0.0050	0.0500	0.750	109.000	.0050	0.030	91.2	.00100	0.88
OCT91	6.95	1735.0	458	0.2500	0.0750	0.580	83.500	.0050	0.025	90.8	.00150	0.86
MAR92	6.88	1300.0	360	0.0050	0.0380	.	70.000	.0060	0.010	68.0	.00025	0.69

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.0250	0.0025	6.00	0.22	1.0000	0.1400	92	6.90	0.790
DEC86	194.0	0.080	0.3000	0.0010	6.00	1.00	0.0050	0.0300	900	38.00	0.029
FEB87	93.0	0.130	0.3200	0.0010	3.50	0.51	0.0050	0.0050	190	29.50	2.350
JUN87	2320.0	0.050	0.0600	0.0010	6.50	0.54	0.0100	0.0250	320	17.40	0.783
SEP87	28.0	0.015	0.0150	0.0010	2.50	0.41	0.0025	0.0050	96	2.10	0.039
NOV87	26.5	0.015	0.0150	0.0010	3.00	0.36	0.0025	0.0050	65	1.00	0.016
MAR88	21.6	0.015	0.0150	0.0010	3.50	0.20	0.0025	0.0050	27	1.20	0.007
NOV89	61.2	0.472	0.0184	0.0050	1.00	0.26	0.0500	0.0025	512	2.00	0.005
MAY90	28.8	0.076	0.0150	0.0025	1.00	0.14	0.0800	0.0070	150	3.00	0.070
DEC90	33.0	0.070	0.0150	0.0030	2.50	0.05	0.0025	0.0050	184	21.40	0.030
MAY91	77.4	0.090	0.3200	0.0010	7.18	0.18	.	0.0500	141	0.05	0.011
OCT91	80.5	0.060	0.3300	0.0250	1.00	0.50	0.0250	0.0050	157	5.00	0.005
MAR92	59.0	0.080	0.2100	0.0025	1.60	0.05	0.1100	0.0140	70	8.50	0.032

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-10

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	6.10	7.5	106	0.00500	0.0005	0.170	.	.0050	0.0100	1.000	.00050	0.610
MAY86	5.20	44.0	33	0.00015	0.0010	0.050	0.510	.0025	0.0100	0.015	.00100	0.070
SEP86	5.70	92.0	40	0.00500	0.0040	0.050	0.450	.0025	0.0100	2.200	.00050	0.040
DEC86	5.50	92.0	33	0.00500	0.0025	0.050	0.640	.0025	0.0050	0.230	.00015	0.060
FEB87	5.10	684.0	33	0.00500	0.0060	0.050	1.000	.0025	0.0100	0.110	.00350	0.005
JUN87	5.00	40.0	31	0.00750	0.0030	0.050	1.000	.0025	0.0100	0.015	.00050	0.001
SEP87	5.20	12.0	30	0.00150	0.0050	0.100	0.870	.0025	0.0100	0.015	.00050	0.005
NOV87	5.20	32.0	30	0.00500	0.0025	0.050	0.900	.0025	0.0100	0.130	.00015	0.001
MAR88	5.90	40.0	27	0.00500	0.0025	0.050	0.930	.0025	0.0100	0.015	.00050	0.005
NOV89	5.95	52.0	34	0.00500	0.0050	0.100	2.600	.0010	0.0100	0.983	.00010	0.271
MAY90	6.40	68.0	33	0.00250	0.0025	0.037	1.860	.0025	0.0040	6.370	.00010	.
DEC90	5.40	84.0	35	0.00500	0.0050	0.250	1.100	.0025	0.0100	0.040	.00025	0.040
MAY91	6.44	37.0	30	0.00500	0.0250	0.050	2.250	.0050	0.0200	8.380	.00100	0.110
OCT91	6.08	43.0	29	0.25000	0.0750	0.100	2.860	.0050	0.0250	19.200	.00150	0.280
MAY92	6.20	44.0	35	0.00500	0.0025	.	2.200	.0025	0.0050	2.700	.00025	0.050
NOV92	6.40	110.0	30	0.00500	0.0025	0.100	2.900	.0025	0.0100	14.000	.00025	0.190
MAY93	.	.	.	0.25000	.	.	3.600	.0050	0.0250	4.800	.	0.200
MAY93	6.25	37.0	25	0.25000	0.0050	0.100	3.400	.0050	0.0250	1.100	.00100	0.170
NOV93	6.40	27.0	43	0.02500	0.0050	0.100	2.500	.0050	0.0250	1.900	.00100	2.400
MAY94	6.10	26.0	32	0.00250	0.0005	0.200	1.887	.0005	0.0025	0.569	.00010	0.025
NOV94	6.20	40.0	37	0.00250	0.0050	0.013	2.522	.0010	0.0025	0.830	.00030	0.016

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	.	0.0025	2.50	0.050	0.0700	0.0250	27.0	0.90	0.183
MAY86	1.600	0.015	0.0200	0.0005	1.50	0.100	0.0025	0.0050	11.0	4.00	0.031
SEP86	1.700	0.015	0.0200	0.0005	2.00	0.075	0.0025	0.0150	8.5	5.60	0.027
DEC86	1.800	0.010	0.0150	0.0025	1.00	0.050	0.0025	0.0050	1.0	0.30	0.042
FEB87	1.700	0.015	0.0150	0.0010	0.25	0.050	0.0025	0.0400	1.0	10.80	0.066
JUN87	1.300	0.015	0.0150	0.0010	3.50	0.050	0.0025	0.0300	6.0	1.40	0.037
SEP87	1.500	0.015	0.0150	0.0025	7.00	0.050	0.0025	0.0050	2.5	1.40	0.026
NOV87	1.800	0.015	0.0150	0.0010	11.50	0.050	0.0025	0.0350	2.5	0.50	0.023
MAR88	1.700	0.015	0.0150	0.0010	4.50	0.050	0.0025	0.0050	2.5	0.50	0.009
NOV89	4.620	0.010	15.4000	0.0050	1.50	0.040	0.0500	0.0025	16.5	7.00	0.005
MAY90	1.620	0.025	0.0150	0.0025	0.50	0.070	0.0200	0.0025	30.0	0.50	0.005
DEC90	1.000	0.015	0.0150	0.0030	3.00	0.050	0.0025	0.0200	2.5	1.20	0.022
MAY91	1.620	0.015	0.0150	0.0250	0.58	0.110	0.0500	0.0050	2.5	0.50	0.005
OCT91	1.780	0.060	0.0400	0.0250	0.50	0.500	0.0050	0.0050	2.8	2.50	0.005
MAY92	2.500	0.015	0.0003	0.0025	0.50	0.050	.	0.0025	7.5	2.30	0.005
NOV92	2.200	0.015	0.0080	0.0025	2.10	0.050	0.0800	0.0025	1.5	3.50	0.005
MAY93	5.300	0.020	.	.	.	.	.	.	.	.	.
MAY93	5.200	0.020	0.0068	0.0050	1.00	0.320	0.0100	0.0250	5.0	0.25	.
NOV93	5.000	0.020	0.0300	0.0050	0.50	0.050	0.0100	0.0050	12.0	1.30	.
MAY94	1.700	0.003	0.0100	0.0010	0.50	0.250	0.0100	3.0000	1.8	0.50	0.010
NOV94	2.535	0.003	0.0100	0.0050	2.70	0.250	0.0100	3.0000	1.7	0.50	0.057

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-11

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	6.20	8.7	83	0.00500	0.0005	0.050	.	.0050	0.010	0.340	.00050	0.060
MAY86	4.90	68.0	72	0.00015	0.0010	0.050	1.000	.0025	0.010	0.015	.00030	0.020
SEP86	4.90	88.0	80	0.00500	0.0040	0.050	1.300	.0025	0.010	0.470	.00050	0.010
DEC86	5.40	6.8	83	0.00500	0.0025	0.050	1.400	.0025	0.005	0.085	.00010	0.016
FEB87	5.90	692.0	86	0.00500	0.0170	0.050	2.500	.0025	0.010	0.300	.00050	0.005
JUN87	4.60	172.0	79	0.00750	0.0030	0.050	1.400	.0025	0.010	0.130	.00050	0.020
SEP87	4.60	72.0	78	0.00150	0.0050	0.100	1.100	.0025	0.010	0.800	.00050	0.005
NOV87	4.50	84.0	83	0.00500	0.0025	0.050	1.200	.0025	0.010	9.300	.00015	0.001
MAR88	4.90	144.0	79	0.00500	0.0025	0.050	1.500	.0025	0.010	0.210	.00050	0.005
NOV89	5.40	61.0	88	0.00500	0.0050	0.100	3.600	.0010	0.010	0.221	.00010	0.037
MAY90	6.00	94.0	89	0.00250	0.0025	0.242	3.270	.0025	0.032	58.700	.00010	.
DEC90	4.90	84.0	97	0.00500	0.0050	0.250	1.100	.0025	0.010	0.070	.00025	0.050
MAY91	7.27	63.0	95	0.00500	0.0250	0.200	3.770	.0050	0.030	32.700	.00100	0.070
OCT91	5.31	75.0	82	0.25000	0.0750	1.100	3.680	.0050	0.160	327.000	.00150	0.500
MAY92	5.40	60.0	92	0.00500	0.0025	.	4.000	.0025	0.040	77.000	.00025	0.120
NOV92	5.50	70.0	77	0.00500	0.0025	0.100	2.700	.0025	0.010	22.000	.00025	0.050
MAY93	5.40	81.0	550	0.25000	0.0050	0.100	3.100	.0050	0.025	3.100	.00100	0.023
NOV93	5.43	43.0	62	0.02500	0.0050	0.100	2.500	.0050	0.025	6.000	.00100	0.018
MAY94	5.70	71.3	86	0.00250	0.0005	0.500	5.065	.0005	0.006	4.941	.00010	0.079
NOV94	5.30	60.0	63	0.00250	0.0050	0.065	1.949	.0020	0.005	7.367	.00010	0.022

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.025	0.0025	0.5	.	1.7000	0.0250	15.0	2.70	0.0930
MAY86	3.800	0.015	0.020	0.0005	5.5	0.09	0.0025	0.0050	3.0	9.50	0.0550
SEP86	3.100	0.015	0.020	0.0005	8.0	0.05	0.0025	0.0150	1.0	4.80	0.2500
DEC86	6.200	0.010	0.015	0.0025	7.5	0.05	0.0025	0.0050	1.0	0.80	0.1180
FEB87	4.700	0.015	0.015	0.0010	8.5	0.05	0.0025	0.0400	1.0	10.70	0.0660
JUN87	3.600	0.015	0.015	0.0010	10.5	0.05	0.0025	0.0200	7.0	0.08	0.0360
SEP87	3.900	0.015	0.015	0.0025	5.0	0.05	0.0025	0.0050	6.6	0.50	0.0510
NOV87	4.600	0.015	0.015	0.0010	12.5	0.13	0.0025	0.0400	2.5	3.60	0.0170
MAR88	4.500	0.015	0.015	0.0005	14.0	0.05	0.0025	0.0050	2.5	0.50	0.0028
NOV89	7.950	0.010	11.800	0.0050	10.3	0.02	0.0500	0.0025	3.5	7.00	0.0050
MAY90	4.360	0.025	0.015	0.0025	9.0	0.05	0.0800	0.0025	21.0	4.00	0.0210
DEC90	3.300	0.015	0.015	0.0030	15.0	0.05	0.0025	0.0050	2.5	0.50	0.0130
MAY91	4.140	0.015	0.015	0.0250	10.4	0.05	5.0000	0.0050	2.5	0.50	0.0200
OCT91	5.000	0.120	0.160	0.0250	14.0	0.50	0.0050	0.0050	0.5	2.50	0.0050
MAY92	4.800	0.015	0.015	0.0025	9.7	0.05	.	0.0025	1.5	1.10	0.0050
NOV92	5.000	0.015	0.007	0.0025	11.0	0.05	0.1100	0.0025	1.5	14.00	0.1300
MAY93	5.300	0.020	0.025	0.0050	9.1	0.20	0.0100	0.0250	5.0	1.40	.
NOV93	2.500	0.020	0.030	0.0050	7.5	0.05	.	0.0050	0.5	3.30	.
MAY94	3.300	0.003	0.010	0.0050	6.2	0.25	0.0100	3.0000	0.5	1.40	0.0220
NOV94	3.646	0.006	0.010	0.0050	7.1	0.25	0.0100	3.0000	0.5	19.10	0.0270

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-12

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	6.50	6.8	88	0.00500	0.0005	0.050	.	0.0050	0.0100	0.760	.00050	0.280
MAY86	5.20	68.0	49	0.00015	0.0010	0.050	0.460	0.0025	0.0100	0.290	.00200	0.020
SEP86	5.30	176.0	58	0.00500	0.0040	0.050	0.390	0.0025	0.0100	6.800	.00050	0.040
DEC86	5.50	144.0	54	0.00500	0.0025	0.050	0.620	.	0.0050	0.930	.00010	0.050
FEB87	5.30	732.0	52	0.00500	0.0025	0.050	1.900	0.0025	0.0100	1.500	.00050	0.005
JUN87	5.20	100.0	54	0.00750	0.0015	0.050	1.200	0.0025	0.0100	0.140	.00050	0.020
SEP87	5.50	44.0	47	0.00150	0.0050	0.100	1.000	0.0025	0.0100	0.320	.00050	0.005
OCT87	5.40	172.0	49	0.00500	0.0050	0.050	1.200	0.0025	0.0050	0.670	.00015	0.020
MAR88	6.20	84.0	44	0.00500	0.0025	0.050	0.760	0.0050	0.0100	0.020	.00025	0.020
OCT88	5.50	56.0	44	0.00500	0.0025	0.500	0.590	0.0050	0.0100	0.090	.00025	0.010
NOV89	6.79	61.0	116	0.00500	0.0050	0.100	6.700	0.0010	0.0100	1.430	.00010	0.585
MAY90	6.50	300.0	64	0.00250	0.0025	0.246	4.860	0.0025	0.0650	86.400	.00010	8.750
DEC90	5.80	116.0	69	0.00500	0.0050	0.250	2.700	0.0025	0.0100	0.120	.00025	0.190
MAY91	7.89	83.0	70	0.00500	0.0250	0.180	5.310	0.0050	0.0500	62.500	.00100	1.990
OCT91	6.15	128.0	64	0.25000	0.0750	0.100	4.000	0.0050	0.0250	16.000	.00150	0.520
JUN92	6.50	210.0	82	0.00500	0.0025	.	5.400	0.0025	0.0100	33.000	.00025	1.100
NOV92	6.40	150.0	91	0.00500	0.0025	0.100	5.200	0.0025	0.0050	9.600	.00025	0.260
MAY93	6.15	91.0	740	0.25000	0.0050	0.100	5.500	0.0050	0.0250	1.100	.00100	0.081
NOV93	6.48	78.0	76	0.02500	0.0050	0.100	2.500	0.0050	0.0250	2.800	.00100	0.084
MAY94	6.10	62.0	81	0.00250	0.0005	0.050	5.219	0.0010	0.0025	0.416	.00010	0.026
NOV94	6.20	115.0	88	0.00250	0.0050	0.027	4.336	0.0240	0.0025	3.165	.00080	0.107

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.02500	0.0025	5.00	0.150	0.6300	0.0250	21.0	4.50	0.119
MAY86	4.500	0.040	0.02000	0.0005	2.50	0.100	0.0025	0.0050	13.0	3.80	0.082
SEP86	2.500	0.015	0.02000	0.0005	3.00	0.105	0.0025	0.0150	1.0	4.80	0.022
DEC86	3.900	0.010	0.01500	0.0025	2.00	0.050	0.0025	0.0050	9.0	2.90	0.089
FEB87	3.300	0.015	0.01500	0.0010	1.00	0.120	0.0025	0.0400	11.0	7.30	0.108
JUN87	2.100	0.015	0.01500	0.0010	3.50	0.050	0.0025	0.0050	19.0	0.50	0.056
SEP87	2.900	0.015	0.01500	0.0010	3.00	0.100	0.0025	0.0730	9.3	0.50	0.034
OCT87	3.400	0.015	0.01500	0.0020	2.50	0.050	0.0025	0.0660	10.0	6.50	0.026
MAR88	2.900	0.015	0.01000	0.0025	3.00	0.150	0.0025	0.0050	2.5	0.50	0.030
OCT88	3.300	0.015	0.01500	0.0005	6.50	0.050	0.0025	0.0050	5.7	0.25	0.014
NOV89	7.200	0.010	0.01780	0.0050	2.00	0.080	0.0500	0.0025	18.5	7.00	0.005
MAY90	3.550	0.068	0.03200	0.0025	2.00	0.110	0.0050	0.0025	34.0	5.00	0.056
DEC90	3.300	0.015	0.01500	0.0030	5.00	0.050	0.0025	0.0050	12.0	0.50	0.008
MAY91	3.880	0.030	0.05000	0.0250	2.11	0.120	0.5600	0.0050	11.8	0.05	0.042
OCT91	3.910	0.060	0.04000	0.0250	2.60	0.500	0.0050	0.0050	11.1	2.50	0.005
JUN92	5.600	0.015	0.00800	0.0025	3.20	0.050	.	0.0025	25.0	1.20	0.005
NOV92	6.000	0.015	0.00025	0.0025	4.50	0.050	0.1000	0.0025	12.0	1.80	0.060
MAY93	7.900	0.020	0.02500	0.0050	3.50	0.072	.	0.0250	20.0	11.00	.
NOV93	2.500	0.020	0.03000	0.0050	1.80	0.050	0.0100	0.0050	13.0	2.70	.
MAY94	4.920	0.003	0.01000	0.0010	3.40	0.250	0.0100	3.0000	13.6	3.90	0.003
NOV94	4.821	0.003	0.01000	0.0050	3.40	0.250	0.0100	3.7500	17.0	9.00	0.020

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WELL=MW-13

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR88	6.10	80	34	0.0050	0.0025	0.05	0.710	0.0050	0.0100	0.170	0.00025	0.350
OCT88	5.40	60	34	0.0050	0.0025	0.50	0.200	0.0050	0.0100	3.200	0.00200	0.340
NOV89	5.72	500	775	0.0050	0.0050	0.27	51.400	0.0020	0.0100	16.100	2.40000	8.650
MAY90	6.10	880	1200	0.0025	0.0025	1.10	81.500	0.0025	0.1130	167.000	0.00090	.
DEC90	5.30	1872	2450	0.0050	0.0050	0.25	178.000	0.0025	0.0100	0.570	0.00090	10.600
MAY91	7.41	2580	3000	0.2500	0.0250	1.39	213.000	0.0200	0.1300	196.000	0.00200	14.200
OCT91	5.67	2860	2873	0.2500	0.0750	0.41	197.000	0.0050	0.1000	49.100	0.00150	11.000
JUN92	5.80	3800	4500	0.0050	0.0025	.	200.000	0.0025	0.1000	140.000	0.00130	16.000
NOV92	5.90	3400	4600	0.0050	0.0025	0.21	210.000	0.0025	0.0200	33.000	0.00025	17.000
MAY93	5.80	3800	340000	0.2500	0.0050	0.10	170.000	0.0050	0.0250	19.000	0.00100	15.000
NOV93	6.69	4200	4900	0.0250	0.0050	0.10	140.000	0.0050	0.0250	5.300	0.00100	1.400
MAY94	6.00	4013	5350	0.0025	0.0005	0.05	115.962	0.0005	0.0025	0.942	0.00030	11.701
NOV94	6.70	4070	5520	0.0025	0.0050	0.91	106.745	0.0190	0.1020	137.310	0.00220	10.660

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR88	2.40	0.015	0.0100	0.0020	3.5	0.05	0.0025	0.0050	13.0	0.50	0.011
OCT88	2.10	0.015	0.0150	0.0005	2.0	0.05	0.0025	0.0050	2.5	0.75	0.024
NOV89	38.90	0.043	11.4000	0.0050	88.8	0.03	0.0500	0.0025	235.0	14.00	111.000
MAY90	78.90	0.116	0.0430	0.0025	100.0	0.07	0.0700	0.0025	349.0	23.00	0.115
DEC90	204.00	0.015	0.0150	0.0030	185.0	0.70	0.0250	0.0050	1100.0	11.20	0.095
MAY91	318.00	0.120	0.1450	0.0100	168.0	0.32	0.0250	0.0050	1720.0	3.00	0.083
OCT91	453.00	0.060	0.0400	0.0250	268.0	0.50	0.0050	0.0050	1568.0	17.00	0.208
JUN92	640.00	0.090	0.0340	0.0025	210.0	0.05	.	0.0025	2400.0	5.20	0.120
NOV92	740.00	0.030	0.0003	0.0025	230.0	0.05	0.0500	0.0025	2600.0	6.70	0.120
MAY93	750.00	0.020	0.0250	0.0050	180.0	0.59	.	0.0250	2400.0	25.00	.
NOV93	910.00	0.020	0.0300	0.0050	220.0	0.05	0.0100	0.0050	3000.0	7.50	.
MAY94	1424.00	0.012	0.0100	0.0670	187.8	0.25	0.0100	3.0000	4518.0	7.40	0.236
NOV94	106.68	0.090	0.0200	0.0050	175.7	0.25	0.0100	3.7500	1880.0	6.90	0.262

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WELL=MW-14

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR92	6.09	100	150	0.1000	.0025	.	92.000	0.0500	4.0000	2100.00	.00080	50.000
MAY92	6.60	160	240	0.1000	.0025	.	43.000	0.0500	1.8000	970.00	.00025	20.000
NOV92	6.00	70	120	0.0050	.0025	1.600	9.400	0.0025	0.1600	82.00	.00025	1.800
MAY93	5.66	30	910	0.2500	.0050	3.750	7.800	0.0050	0.0250	18.00	.00100	2.900
NOV93	6.49	140	110	0.0250	.0050	0.005	0.005	0.7100	0.0650	34.00	.00100	1.000
MAY94	5.80	80	109	0.0025	.0020	0.100	6.608	0.0005	0.0025	0.67	.00010	0.270
NOV94	6.70	82	128	0.0025	.0050	11.680	29.727	0.0760	1.2200	521.11	.00050	11.896

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR92	40.000	2.200	0.280	.0025	25.0	0.05	0.03	0.0025	1.5	3.2	0.005
MAY92	11.000	0.890	0.150	.0025	40.0	0.05	.	0.0025	3.1	2.3	0.010
NOV92	7.000	0.080	0.016	.0025	19.0	0.05	0.02	0.0025	1.5	1.4	0.005
MAY93	9.300	0.020	0.016	.0050	13.0	0.67	.	0.0250	5.0	4.5	.
NOV93	7.100	0.020	0.030	.0050	17.0	0.05	0.01	0.0050	0.5	2.4	.
MAY94	6.750	0.003	0.010	.0010	20.8	0.25	0.01	3.3500	1.5	6.7	0.008
NOV94	9.713	0.636	0.130	.0050	23.4	0.25	0.03	3.7500	1.5	6.3	0.078

WELL=MW-15

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR92	6.03	120	61	0.1000	.0025	.	32.000	0.0500	0.9700	1200.00	.00025	16.000
MAY92	6.40	38	56	0.0400	.0025	.	7.100	0.0025	0.1900	200.00	.00025	26.000
NOV92	6.50	18	31	0.0050	.0025	4.200	8.500	0.0025	0.2500	280.00	.00025	4.100
MAY93	6.33	5	320	0.2500	.0050	1.700	4.800	0.0050	0.0250	19.00	.00100	0.920
NOV93	6.91	40	46	0.0250	.0050	2.500	5.400	0.0050	0.1700	190.00	.00100	2.000
MAY94	6.20	35	25	0.0025	.0020	0.100	2.569	0.0010	0.0025	2.85	.00010	0.141
NOV94	7.00	33	30	0.0025	.0050	2.232	7.262	0.0190	0.1380	142.20	.00010	2.002

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR92	32.00	0.300	0.200	.0025	0.5	0.05	0.03	0.0250	1.5	2.0	0.005
MAY92	3.40	0.110	0.037	.0025	0.5	0.05	.	0.0050	1.5	1.8	0.005
NOV92	4.20	0.130	0.075	.0025	2.1	0.05	0.20	0.0025	1.5	2.2	0.005
MAY93	4.60	0.020	0.016	.0050	0.5	0.27	.	0.0250	5.0	2.9	.
NOV93	2.50	0.090	0.030	.0050	0.5	0.05	0.01	0.0320	7.2	1.7	.
MAY94	2.79	0.003	0.010	.0010	0.9	0.25	0.01	3.3500	1.1	3.0	0.006
NOV94	2.46	0.076	0.040	.0050	3.7	0.25	0.01	3.7500	2.0	0.5	0.030

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WELL=MW-1A

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR92	6.53	56	53	0.0050	.0025	.	24.000	0.0025	0.5200	540.000	.00025	7.000
MAY92	6.60	42	56	0.0050	.0025	.	5.400	0.0025	0.0700	72.000	.00025	1.200
NOV92	6.50	55	43	0.0050	.0025	2.400	6.700	0.0025	0.1600	160.000	.00025	1.900
MAY93	6.32	52	33	0.2500	.0050	0.100	4.300	0.0050	0.0250	15.000	.00100	0.720
NOV93	6.70	31	43	0.0250	.0050	0.100	2.500	0.0050	0.0250	10.000	.00100	0.270
MAY94	6.10	59	33	0.0025	.0005	0.050	2.437	0.0005	0.0025	2.076	.00010	0.214
NOV94	6.00	39	26	0.0025	.0050	2.688	6.266	0.0220	0.1970	191.550	.00050	1.568

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR92	5.700	0.260	0.054	.0025	1.9	0.05	0.02	0.0100	1.5	0.50	0.005
MAY92	3.000	0.040	0.007	.0025	0.5	0.05	.	0.0025	3.0	0.50	0.005
NOV92	3.200	0.080	0.018	.0025	1.4	0.05	0.05	0.0025	22.0	4.20	0.005
MAY93	5.600	0.020	0.012	.0050	0.5	0.70	0.01	0.0250	5.0	0.25	.
NOV93	2.500	0.020	0.020	.0050	0.5	0.05	0.01	0.0050	0.5	1.60	.
MAY94	2.160	0.003	0.010	.0040	0.9	0.25	0.01	3.0000	2.8	2.90	0.003
NOV94	2.285	0.095	0.010	.0050	1.1	0.25	0.01	3.7500	0.5	4.20	0.018

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WELL=MW-2

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	7.30	9.4	266.0	0.00500	0.0001	0.050	.	0.0050	0.010	1.900	.00025	0.200
MAY86	6.00	860.0	220.0	0.00015	0.0050	0.050	15.500	0.0025	0.010	0.015	.00270	4.000
SEP86	7.00	4550.0	5780.0	0.02000	0.0490	0.050	19.500	0.0025	0.010	7.700	.00100	2.300
DEC86	11.50	13400.0	14500.0	0.02000	0.2500	0.050	0.020	.	0.040	12.900	.00300	0.230
FEB87	11.00	12080.0	10900.0	0.00500	0.7700	0.050	0.010	0.0025	0.040	14.800	.00090	0.100
JUN87	10.20	8944.0	9820.0	0.01500	0.2400	0.050	0.030	0.0025	0.010	8.700	.00150	0.110
SEP87	10.20	10320.0	11500.0	0.00300	0.0300	0.100	0.080	0.0050	0.020	17.000	.00300	0.050
OCT87	9.60	9980.0	10900.0	0.12500	0.1250	0.050	0.070	0.0025	0.005	9.000	.00060	0.040
MAR88	9.70	9070.0	9470.0	0.00500	0.1300	0.050	0.100	.	0.010	1.700	.00100	0.020
OCT88	9.20	8300.0	9380.0	0.00500	0.2200	0.500	0.820	0.0050	0.010	3.000	.00320	0.030
NOV89	9.10	8590.0	10970.0	0.01000	0.0300	0.100	17.700	0.0130	0.010	2.120	.00010	0.105
MAY90	8.50	8000.0	8200.0	0.00250	0.0125	0.074	43.900	0.0060	0.025	23.500	.00010	.
DEC90	7.90	7384.0	9160.0	0.00500	0.0050	0.250	18.200	0.0025	0.010	0.760	.00025	0.230
MAY91	8.41	6367.0	9000.0	0.00500	0.0100	0.040	21.500	0.0050	0.170	7.470	.00100	0.270
OCT91	8.34	6983.0	6791.0	0.25000	0.0750	0.100	15.900	0.0050	0.025	1.740	.00150	0.150
MAY92	9.10	.	10000.0	.	.	.	.	.	.	.	.	.
NOV92	9.50	10000.0	13000.0	0.00500	0.2800	0.100	5.200	0.0025	0.010	5.100	.00025	0.050
MAY93	.	.	.	0.25000	0.0820	0.100	3.200	0.0050	0.025	2.200	.00100	0.026
NOV93	9.69	8200.0	10000.0	0.02500	0.0630	0.100	2.500	0.0050	0.050	4.000	.00100	0.027
MAY94	9.60	7768.0	12020.0	0.00250	0.0640	0.050	3.298	0.0005	0.005	2.956	.00010	0.053
NOV94	9.60	8783.0	115.6	0.00250	0.0050	0.009	16.171	0.0005	0.006	3.277	.00010	0.033

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.0250	0.0025	13.5	0.75	1.9000	0.025	46.0	4.2	0.090
MAY86	175.00	0.120	0.0200	0.0005	66.0	0.73	0.0025	0.005	490.0	29.5	0.010
SEP86	1060.00	0.420	0.0900	0.0030	45.0	4.20	0.0025	0.170	960.0	630.0	0.430
DEC86	3100.00	0.820	0.1900	0.0200	440.0	10.00	0.1000	0.810	1160.0	620.0	0.730
FEB87	2630.00	0.350	0.0600	0.0270	500.0	21.00	0.0250	1.000	1400.0	524.0	0.851
JUN87	2775.00	0.390	0.0500	0.0023	500.0	8.70	0.0100	0.850	2200.0	254.0	3.660
SEP87	2200.00	0.340	0.0250	0.0030	440.0	11.70	0.0250	0.005	1700.0	780.0	0.680
OCT87	3100.00	0.350	0.6000	0.0020	345.0	10.00	0.0050	0.930	1430.0	900.0	0.200
MAR88	2690.00	0.360	0.0200	0.0130	150.0	11.00	0.0250	0.030	1700.0	520.0	0.350
OCT88	2600.00	0.130	0.0400	0.0050	47.5	7.00	0.0050	0.070	1100.0	72.0	0.580
NOV89	3280.00	0.261	5.3900	0.0050	342.0	2.84	0.0500	5.400	2100.0	0.5	496.000
MAY90	2310.00	0.127	0.1400	0.0025	2.0	0.95	0.0050	0.036	1740.0	170.0	0.217
DEC90	2100.00	0.120	0.0150	0.0030	14.5	1.40	0.0025	0.005	2080.0	279.0	0.160
MAY91	2050.00	0.060	0.0800	0.0100	278.0	1.30	0.5000	0.005	1610.0	222.0	0.116
OCT91	2230.00	0.060	0.0400	0.0250	251.0	0.50	0.0100	0.005	58.3	570.0	0.103
MAY92	.	.	.	.	360.0	4.00	.	.	.	280.0	0.300
NOV92	3800.00	0.550	0.0530	0.0025	520.0	0.05	0.1600	0.005	1900.0	340.0	0.490
MAY93	2900.00	0.320	0.0062	0.0050	350.0	6.20	.	.	1450.0	.	.
NOV93	2400.00	0.027	0.0300	0.0050	360.0	6.50	0.0100	0.011	2300.0	230.0	.
MAY94	21080.00	0.203	0.0200	0.0180	395.2	6.10	0.0100	.	1742.0	356.0	0.361
NOV94	2.98	0.197	0.0200	0.0050	414.2	4.29	0.0100	3.750	1175.0	348.0	0.278

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Listing of
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WELL=MW-3A

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR88	7.60	220.0	90	0.0050	0.0025	0.050	3.000	.0050	0.0100	0.130	.00025	0.005
OCT88	7.00	108.0	96	0.0050	0.0025	0.500	2.300	.0050	0.0100	2.200	.00025	0.005
NOV89	6.86	76.0	111	0.0050	0.0050	0.100	6.900	.0010	0.0100	10.300	.00010	0.028
MAY90	6.50	110.0	83	0.0025	0.0050	0.151	4.100	.0025	0.0340	39.500	.00010	.
DEC90	6.80	204.0	111	0.0050	0.0050	0.500	5.500	.0025	0.0100	5.900	.00025	0.030
MAY91	8.83	89.0	110	0.0050	0.0100	0.020	9.390	.0050	0.0050	20.100	.00100	0.040
JUN92	7.40	110.0	110	0.0050	0.0025	.	12.000	.0070	0.0050	21.000	.00025	0.060
NOV92	7.40	91.0	100	0.0050	0.0025	0.050	1.100	.0025	0.0050	7.500	.00025	0.030
MAY93	7.59	90.0	1100	0.2500	0.0050	0.100	12.000	.0050	0.0250	3.900	.00100	0.038
NOV93	7.64	9.8	130	0.0180	0.0050	0.100	11.000	.0050	0.0250	3.800	.00100	0.032
MAY94	7.40	107.0	158	0.0025	0.0005	0.100	16.574	.0005	0.0025	6.103	.00010	0.049
NOV94	8.00	94.0	173	0.0025	0.0050	0.007	16.504	.0005	0.0025	1.215	.00010	0.057

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR88	5.700	0.015	0.01000	0.0025	6.00	0.20	0.0025	0.0500	10.0	3.60	0.016
OCT88	7.000	0.015	0.01500	0.0005	7.50	0.10	0.0025	0.0200	11.0	0.25	0.016
NOV89	8.820	0.010	7.59000	0.0050	0.50	0.16	0.0500	0.0025	19.0	9.00	0.005
MAY90	7.380	0.025	0.01500	0.0025	0.50	0.16	0.0200	0.0025	32.0	0.50	0.160
DEC90	6.200	0.040	0.01500	0.0030	6.00	0.05	0.0025	0.0050	16.0	9.30	0.040
MAY91	8.580	0.015	0.01500	0.0100	1.25	0.20	0.0250	0.0050	10.3	0.50	0.005
JUN92	7.800	0.015	0.00500	0.0025	1.50	0.10	0.0100	0.0025	17.0	0.50	0.005
NOV92	6.800	0.015	0.00025	0.0025	1.10	0.10	0.0400	0.0025	14.0	3.90	0.005
MAY93	9.400	0.020	0.02500	0.0050	1.00	0.12	.	0.0250	14.0	6.00	.
NOV93	7.100	0.020	0.03000	0.0050	0.50	0.12	0.0100	0.0050	9.2	2.50	.
MAY94	9.130	0.003	0.01000	0.0010	2.90	0.25	0.0100	3.0000	6.6	4.20	0.012
NOV94	7.878	0.003	0.01000	0.0050	4.70	0.25	0.0100	3.7500	6.1	7.70	0.020

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-4

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	6.20	6	132	0.00500	0.0024	0.650	.	0.0050	0.010	60.000	.00025	1.300
MAY86	4.10	68	72	0.00015	0.0010	0.050	0.580	0.0025	0.010	0.015	.00040	0.240
SEP86	5.50	168	83	0.00500	0.0040	0.050	0.730	0.0025	0.010	6.000	.00050	0.090
DEC86	5.70	200	73	0.00500	0.0050	0.050	0.570	.	0.005	0.450	.00050	0.090
FEB87	4.60	700	57	0.00500	0.0025	0.050	1.600	0.0025	0.010	0.015	.00050	0.080
JUN87	5.40	268	241	0.00750	0.0050	0.050	4.600	0.0025	0.010	3.900	.00050	1.700
SEP87	6.30	180	78	0.00150	0.0050	0.100	1.200	0.0025	0.010	2.000	.00015	0.260
OCT87	5.40	160	94	0.00500	0.0050	0.050	4.000	0.0025	0.005	7.300	.00015	0.460
MAR88	6.10	236	238	0.00500	0.0025	0.050	2.100	0.0050	0.010	23.000	.00100	0.610
OCT88	5.80	630	778	0.00500	0.0025	0.500	5.300	0.0050	0.010	145.000	.00480	0.060
NOV89	6.01	1840	2330	0.00500	0.0050	0.100	91.200	0.0040	0.010	335.000	.00010	2.920
MAY90	5.00	750	770	0.00250	0.0025	0.157	18.600	0.0120	0.075	92.700	.00020	.
DEC90	4.70	1184	1440	0.00500	0.0050	0.250	59.000	0.0025	0.010	234.000	.00025	3.200
MAY91	5.01	1014	1400	0.25000	0.0250	0.110	51.300	0.0200	0.040	204.000	.00100	2.810
OCT91	.	1575	1742	0.25000	0.0750	0.100	80.100	0.0050	0.050	274.000	.00150	5.020
MAY92	5.70	2600	3200	0.00500	0.0025	.	100.000	0.0025	0.040	330.000	.00025	8.900
NOV92	5.40	2400	3000	0.00500	0.0025	0.050	140.000	0.0025	0.005	330.000	.00025	13.000
MAY93	6.21	1600	270000	0.25000	0.0050	0.100	93.000	0.0050	0.025	250.000	.00100	8.800
NOV93	5.78	2000	2400	0.02500	0.0050	0.100	84.000	0.0050	0.025	330.000	.00100	7.200
MAY94	6.00	2336	3030	0.00250	0.0005	0.200	95.255	0.0005	0.006	223.912	.00030	10.904
NOV94	6.10	1749	2390	0.00250	0.0130	0.162	60.856	0.0240	0.065	240.425	.00040	6.562

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.0250	0.0250	1.0	0.10	0.3600	0.0250	24.0	17.00	0.120
MAY86	3.400	0.015	0.0200	0.0005	1.0	0.16	0.0025	0.0050	31.0	5.90	0.020
SEP86	5.000	0.040	0.0200	0.0005	3.0	0.33	0.0025	0.0650	21.0	10.20	0.036
DEC86	3.900	0.010	0.0150	0.0025	1.5	0.20	0.0025	0.0050	19.0	0.50	0.058
FEB87	2.400	0.015	0.0150	0.0010	2.5	0.05	0.0025	0.0600	23.0	6.60	0.062
JUN87	6.000	0.015	0.0150	0.0010	32.0	0.05	0.0025	0.0250	58.0	1.70	0.122
SEP87	2.100	0.015	0.0150	0.0010	9.5	0.23	0.0025	0.0050	16.0	0.50	0.025
OCT87	3.700	0.015	0.0150	0.0020	8.5	0.10	0.0025	0.1000	2.0	2.30	0.038
MAR88	5.700	0.015	0.0100	0.0025	44.0	0.90	0.0025	0.0300	49.0	0.50	0.160
OCT88	15.800	0.015	0.0150	0.0005	132.0	0.30	0.0025	0.0050	123.0	0.55	0.065
NOV89	94.000	0.027	11.7000	0.0050	250.0	0.02	0.0500	0.0025	900.0	28.00	24.200
MAY90	15.000	8.000	0.0250	0.0480	76.0	193.00	0.1600	0.0025	193.0	14.00	0.230
DEC90	76.000	0.015	0.0150	0.0030	157.0	0.80	0.0025	0.0300	520.0	1.90	0.038
MAY91	54.800	0.120	0.1500	0.0250	154.0	0.05	0.7000	0.0050	561.0	3.00	1.140
OCT91	108.000	0.060	0.0400	0.0250	314.0	0.50	0.0100	0.0050	1303.0	14.00	0.047
MAY92	160.000	0.015	0.0080	0.0025	330.0	0.05	0.0100	0.0025	1000.0	1.80	0.030
NOV92	230.000	0.015	0.0003	0.0025	300.0	0.05	0.1200	0.0025	1200.0	7.80	0.030
MAY93	190.000	0.020	0.0250	0.0050	190.0	0.19	.	0.0250	890.0	5.90	.
NOV93	180.000	0.020	0.0300	0.0550	250.0	0.05	0.0100	0.0050	1500.0	9.50	.
MAY94	220.000	0.003	0.0100	0.0990	234.6	0.25	0.0100	3.0000	1250.6	14.00	0.059
NOV94	184.889	0.036	0.0100	0.0050	194.8	0.25	0.0100	3.7500	92.0	9.10	0.081

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-5A

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR88	6.30	124	90	0.0050	0.0025	0.050	1.800	.0050	0.010	0.310	.00025	2.500
OCT88	5.50	140	65	0.0050	0.0025	0.500	0.200	.0050	0.010	39.000	.00180	1.600
NOV89	5.50	62	97	0.0050	0.0050	0.210	4.300	.0010	0.010	17.800	.00010	0.741
MAY90	6.50	110	83	0.0025	0.0050	0.151	4.100	.0025	0.034	39.500	.00010	.
DEC90	5.40	84	90	0.0050	0.0050	0.250	2.100	.0025	0.010	7.100	.00025	0.460
MAY91	6.50	32	100	0.0050	0.0100	0.180	4.630	.0050	0.040	34.800	.00100	0.530
OCT91	5.69	98	91	0.2500	0.0750	0.380	5.480	.0050	0.080	80.500	.00150	0.770
MAY92	6.00	60	94	0.0050	0.0025	.	4.300	.0025	0.020	19.000	.00025	0.450
NOV92	6.00	31	90	0.0050	0.0025	0.100	4.700	.0025	0.030	30.000	.00025	0.540
MAY93	5.80	69	900	0.2500	0.0050	0.100	4.600	.0050	0.025	17.000	.00100	0.640
NOV93	6.31	56	110	0.0250	0.0050	0.100	2.500	.0050	0.025	5.800	.00100	0.600
MAY94	5.70	72	141	0.0025	0.0005	0.500	5.684	.0005	0.039	28.798	.00030	0.883
NOV94	5.70	151	227	0.0025	0.0050	0.300	12.503	.0070	0.067	68.862	.00060	1.930

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR88	3.900	0.015	0.0100	0.0025	7.50	0.20	0.0025	0.0400	7.00	2.20	0.010
OCT88	4.700	0.040	0.0150	0.0005	8.00	0.05	0.0025	0.0170	12.00	0.25	0.027
NOV89	11.500	0.010	25.7000	0.0050	8.80	0.05	0.0500	0.0025	7.00	22.00	0.005
MAY90	7.380	0.025	0.0150	0.0025	5.00	0.07	0.0500	0.0025	49.00	8.00	0.035
DEC90	7.100	0.015	0.0150	0.0030	12.50	0.05	0.0050	0.0200	16.00	62.00	0.023
MAY91	8.860	0.050	0.0150	0.0100	8.54	0.05	1.5000	0.0050	9.21	1.00	0.041
OCT91	8.490	0.060	0.0400	0.0250	4.00	0.50	0.0050	0.0050	5.40	6.00	0.005
MAY92	9.400	0.030	0.0003	0.0025	8.90	0.05	.	0.0025	16.00	.	3.400
NOV92	8.900	0.030	0.0060	0.0025	9.70	0.05	0.0900	0.0025	22.00	1.80	0.050
MAY93	14.000	0.020	0.0110	0.0050	12.00	0.40	.	0.0250	5.00	9.70	.
NOV93	8.000	0.020	0.0300	0.0050	11.00	0.05	0.0100	0.0050	54.00	1.30	.
MAY94	13.000	0.048	0.0100	0.0140	15.20	0.25	0.0100	3.0000	4.20	2.10	0.003
NOV94	10.102	0.071	0.0100	0.0050	37.70	0.25	0.0200	3.7500	16.60	2.00	0.082

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-6

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	5.40	6.6	168	0.00500	0.0005	0.450	.	.0050	0.010	23.000	.00050	3.600
MAY86	5.00	88.0	101	0.00015	0.0010	0.050	1.100	.0025	0.010	0.015	.00100	0.100
SEP86	5.20	84.0	114	0.00500	0.0040	0.050	1.200	.0025	0.010	0.410	.00050	0.110
DEC86	5.30	96.0	124	0.00500	0.0050	0.050	1.700	.	0.005	0.015	.00050	0.170
FEB87	5.20	828.0	130	0.00500	0.0025	0.050	6.500	.0025	0.010	0.050	.00050	0.130
JUN87	5.10	2452.0	121	0.00750	0.0050	0.050	2.000	.0025	0.010	0.110	.00050	0.050
SEP87	5.10	140.0	96	0.00150	0.0050	0.100	1.700	.0025	0.010	1.900	.00015	0.100
OCT87	4.80	2060.0	86	0.00500	0.0050	0.050	2.100	.0025	0.005	2.600	.00015	0.090
MAR88	5.70	120.0	80	0.00500	0.0025	0.050	1.400	.0050	0.010	0.170	.00025	0.100
OCT88	5.10	104.0	89	0.00500	0.0025	0.500	0.610	.0050	0.010	4.700	.00250	0.380
NOV89	5.73	130.0	180	0.00500	0.0050	0.100	7.050	.0010	0.010	2.640	.00010	0.864
MAY90	6.20	200.0	150	0.00250	0.0025	0.078	7.110	.0025	0.027	29.700	.00030	.
DEC90	5.30	120.0	146	0.00500	0.0050	0.250	3.400	.0025	0.010	0.320	.00025	0.270
MAY91	6.21	155.0	180	0.00500	0.0250	0.090	10.500	.0050	0.050	38.100	.00100	0.450
OCT91	5.69	134.0	133	0.25000	0.0750	0.100	6.670	.0050	0.025	16.700	.00150	0.220
MAY92	6.20	87.0	110	0.00500	0.0025	.	6.500	.0025	0.020	14.000	.00025	0.270
NOV92	6.00	110.0	150	0.00500	0.0025	0.050	8.900	.0025	0.020	2.900	.00800	0.380
MAY93	5.79	110.0	1300	0.25000	0.0050	0.100	9.600	.0050	0.025	4.600	.00100	0.180
NOV93	5.86	120.0	140	0.02500	0.0050	0.100	8.400	.0050	0.025	14.000	.00100	0.200
MAY94	5.70	146.0	233	0.00250	0.0050	0.050	14.528	.0005	0.210	12.982	.00110	0.525
NOV94	5.70	166.0	254	0.00250	0.0050	0.147	15.992	.0050	0.042	50.872	.00210	0.721

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	.	0.0025	4.50	0.05	6.4000	0.0250	23.0	8.50	0.025
MAY86	5.900	0.015	0.0200	0.0005	4.50	0.11	0.0025	0.0050	19.0	5.10	0.016
SEP86	6.500	0.015	0.0200	0.0005	7.50	0.05	0.0025	0.0150	22.0	13.40	0.023
DEC86	7.900	0.010	0.0150	0.0025	7.00	0.10	0.0025	0.0050	23.0	1.10	0.098
FEB87	7.800	0.015	0.0150	0.0010	8.50	0.11	0.0025	0.0600	22.0	10.90	0.038
JUN87	7.200	0.015	0.0150	0.0010	10.00	0.11	0.0025	0.0300	19.0	0.70	0.037
SEP87	5.900	0.015	0.0150	0.0010	7.50	0.05	0.0025	0.0050	16.0	1.00	0.029
OCT87	6.200	0.015	0.0150	0.0020	9.00	0.05	0.0025	0.0630	14.0	10.00	0.047
MAR88	5.800	0.015	0.0100	0.0025	10.00	0.05	0.0025	0.0400	19.0	1.60	0.043
OCT88	7.300	0.030	0.0150	0.0005	7.00	0.05	0.0025	0.0050	22.0	0.25	0.015
NOV89	15.100	0.010	50.8000	0.0050	9.80	0.06	0.0500	0.0025	28.5	19.00	0.005
MAY90	9.200	0.025	0.0370	0.0025	8.00	0.09	0.1700	0.0025	30.0	7.00	0.118
DEC90	7.300	0.015	0.0150	0.0030	9.00	0.80	0.0025	0.0050	36.0	30.30	0.022
MAY91	13.100	0.015	0.0300	0.0250	6.99	0.05	0.8000	0.0500	47.1	1.00	0.005
OCT91	8.020	0.060	0.0400	0.0250	6.20	0.50	0.0050	0.0050	24.7	6.00	0.005
MAY92	7.300	0.015	0.0003	0.0025	43.00	0.05	.	0.0025	8.9	1.70	0.005
NOV92	8.500	0.015	0.0180	0.0025	4.60	0.05	0.0300	0.0025	37.0	1.30	0.005
MAY93	12.000	0.020	0.0130	0.0050	4.00	0.35	.	0.0250	26.0	4.10	.
NOV93	7.600	0.020	0.0300	0.0050	16.00	0.05	0.0100	0.0170	14.0	6.50	.
MAY94	11.000	0.024	0.0100	0.0150	20.00	0.25	0.0100	3.0000	22.3	8.70	0.003
NOV94	10.517	0.032	0.0200	0.0050	34.90	0.25	0.0300	3.7500	13.3	61.00	0.072

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-7A

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
MAR88	6.00	100	69	0.0050	0.0025	0.050	1.600	0.0050	0.0100	0.130	.00025	0.370
OCT88	5.20	84	63	0.0050	0.0025	0.500	0.570	0.0050	0.0100	5.700	.00250	0.140
NOV89	6.19	71	75	0.0050	0.0050	0.100	6.600	0.0010	0.0100	2.070	.00010	0.208
MAY90	6.50	160	170	0.0025	0.0025	0.173	13.300	0.0025	0.0370	79.700	.00010	.
DEC90	5.50	156	219	0.0050	0.0050	0.250	13.200	0.0025	0.0100	0.580	.00025	0.210
MAY91	6.50	168	240	0.0050	0.0100	0.160	14.800	0.0050	0.0400	65.800	.00100	1.270
OCT91	5.98	275	338	0.2500	0.0750	0.100	21.400	0.0050	0.0250	22.600	.00150	3.310
MAY92	6.20	180	250	0.0050	0.0025	.	15.000	0.0025	0.0050	13.000	.00025	2.000
NOV92	6.10	170	260	0.0050	0.0025	0.050	24.000	0.0025	0.0050	20.000	.00025	3.500
MAY93	5.85	240	2400	0.2500	0.0050	0.100	31.000	0.0210	0.0250	3.500	.00100	5.100
NOV93	5.92	230	330	0.0250	0.0050	0.100	21.000	0.0050	0.0250	11.000	.00100	3.200
MAY94	5.80	151	253	0.0025	0.0005	0.050	18.221	0.0005	0.0025	2.452	.00010	20.310
NOV94	5.90	121	203	0.0025	0.0050	0.182	15.344	0.0080	0.0350	78.866	.00200	1.042

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
MAR88	4.400	0.015	0.0100	0.0025	4.0	0.050	0.0025	.	2.5	13.90	0.028
OCT88	4.300	0.015	0.0150	0.0005	5.0	0.200	0.0025	0.0050	9.6	0.25	0.018
NOV89	7.950	0.010	13.9000	0.0050	2.0	0.060	0.0500	0.0025	16.5	9.00	0.005
MAY90	4.700	0.060	0.0150	0.0025	6.0	0.080	0.0100	0.0070	74.0	10.00	0.011
DEC90	5.000	0.015	0.0150	0.0030	6.0	0.050	0.0025	0.0050	140.0	39.80	0.015
MAY91	4.340	0.040	0.0300	0.0100	30.7	0.050	0.1000	0.0500	67.8	0.50	0.014
OCT91	6.040	0.060	0.0400	0.0250	6.0	0.500	0.0050	5.0000	175.0	2.50	0.005
MAY92	6.000	0.015	0.0003	0.0025	7.3	0.050	.	0.0025	84.0	28.00	0.050
NOV92	6.800	0.015	0.0160	0.0025	17.0	0.050	0.1100	0.0025	76.0	7.80	0.070
MAY93	9.000	0.032	0.0250	0.0050	30.0	0.087	0.0100	0.0250	93.0	1.80	.
NOV93	5.900	0.020	0.0300	0.0050	23.0	0.050	0.0100	0.0500	81.0	4.30	.
MAY94	5.700	0.006	0.0100	0.0010	16.7	0.250	0.0100	3.3500	46.9	0.50	0.006
NOV94	6.392	0.051	0.0100	0.0050	11.8	0.250	0.0100	3.7500	44.1	0.50	0.030

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-8

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	5.70	5.1	83	0.0050	0.0005	0.350	.	0.0050	0.080	48.000	.00050	0.430
SEP86	5.50	116.0	74	0.0050	0.0040	0.050	0.810	0.0025	0.010	1.200	.00050	0.030
DEC86	6.40	624.0	86	0.0050	0.0050	0.050	0.220	.	0.005	4.500	.00050	0.050
FEB87	5.30	712.0	66	0.0050	0.0075	0.050	0.950	0.0025	0.030	0.720	.00050	0.030
JUN87	5.30	864.0	72	0.0075	0.0030	0.050	0.800	0.0025	0.010	1.100	.00050	0.050
SEP87	5.40	104.0	66	0.0015	0.0050	0.100	0.850	0.0025	0.010	2.100	.00015	0.010
NOV87	5.30	104.0	65	0.0050	0.0025	0.050	0.740	0.0025	0.010	0.570	.00015	0.050
MAR88	5.90	324.0	64	0.0050	0.0025	0.050	0.750	0.0025	0.010	1.700	.00050	0.090
NOV89	5.58	106.0	112	0.0050	0.0050	0.100	9.900	0.0030	0.010	20.900	.00010	0.231
MAY90	6.70	170.0	77	0.0025	0.0025	0.136	4.880	0.0025	0.019	30.100	.00030	.
DEC90	5.70	84.0	79	0.0050	0.0050	0.250	2.500	0.0025	0.010	7.600	.00025	0.140
MAY91	6.66	76.0	70	0.2500	0.0250	0.900	27.300	0.0200	0.140	230.000	.00100	1.400
OCT91	6.50	103.0	68	0.2500	0.0750	0.100	4.620	0.0050	0.025	19.000	.00150	0.120
MAY92	6.40	67.0	120	0.0050	0.0025	.	3.900	0.0025	0.005	5.300	.00025	0.150
NOV92	6.50	34.0	77	0.0050	0.0025	0.100	6.500	0.0025	0.020	38.000	.00025	0.250
MAY93	6.48	91.0	740	0.2500	0.0050	0.100	3.700	0.0050	0.025	6.200	.00100	0.120
NOV93	6.82	81.0	80	0.0250	0.0050	0.100	2.500	0.0050	0.025	7.700	.00100	0.120
MAY94	6.60	52.0	79	0.0025	0.0010	0.300	4.392	0.0005	0.010	6.556	.00010	0.150
NOV94	6.50	70.0	83	0.0025	0.0050	0.030	4.365	0.0030	0.005	9.229	.00020	0.134

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.6000	0.0025	7.00	0.90	0.4500	0.0250	16.0	3.50	0.0750
SEP86	4.900	0.015	0.0200	0.0005	2.00	0.25	0.0025	0.0150	21.0	9.60	0.0220
DEC86	9.300	0.010	0.0150	0.0025	4.00	0.05	0.0025	0.0050	30.0	2.00	0.0710
FEB87	7.000	0.015	0.0150	0.0010	2.00	0.16	0.0025	0.0300	21.0	9.40	0.0580
JUN87	6.100	0.015	0.0150	0.0010	3.50	0.22	0.0025	0.0050	7.5	0.25	0.0590
SEP87	5.400	0.015	0.0150	0.0025	8.50	0.28	0.0025	0.0900	22.0	6.90	0.0230
NOV87	6.700	0.015	0.0150	0.0010	5.50	0.13	0.0025	0.0300	20.0	2.00	0.0150
MAR88	6.900	0.060	0.0150	0.0010	5.00	0.10	0.0025	0.0050	70.0	0.50	0.0130
NOV89	11.300	0.010	30.7000	0.0050	1.50	0.13	0.0500	0.0025	65.0	4.00	0.0137
MAY90	6.200	3.000	0.0250	0.0150	1.00	0.12	0.1400	0.0025	10.0	1.00	0.3000
DEC90	5.000	0.015	0.0150	0.0030	4.00	0.05	0.0025	0.0050	21.0	23.00	0.0220
MAY91	7.380	0.120	0.1500	0.0100	1.39	0.05	0.1000	0.0050	20.6	2.00	0.0050
OCT91	4.510	0.060	0.0400	0.0150	1.50	0.50	0.0050	0.0050	17.0	6.70	0.0050
MAY92	4.500	0.015	0.0003	0.0025	2.40	0.10	.	0.0025	16.0	0.50	0.0050
NOV92	5.800	0.040	0.0060	0.0025	1.40	0.10	0.1100	0.0025	21.0	3.40	0.0100
MAY93	4.700	0.020	0.0250	0.0050	1.50	0.13	0.0330	0.0250	20.0	0.99	.
NOV93	2.500	0.020	0.0300	0.0050	1.20	0.11	0.0100	0.0050	15.0	1.50	.
MAY94	4.500	0.009	0.0100	0.0010	1.40	0.25	0.0100	3.0000	15.8	3.50	0.0050
NOV94	3.735	0.005	0.0100	0.0050	2.70	0.25	0.0100	3.7500	7.9	13.00	0.0270

Champion International
Canton Landfill No. 6
Canton, North Carolina

Listing of
Groundwater Geochemistry Data

WELL=MW-9

DATE	pH	Total Dissolved Solids	Specific Conductance	Silver	Arsenic	Barium	Calcium	Cadmium	Chromium	Iron	Mercury	Manganese
JUL83	6.40	7	149	0.00500	0.0005	0.050	.	.0050	0.0100	0.890	.00050	0.300
MAY86	5.20	80	73	0.00015	0.0010	0.050	0.190	.0025	0.0100	0.015	.00070	0.190
DEC86	6.20	80	43	0.00500	0.0025	0.050	0.450	.0025	0.0050	0.300	.00015	0.040
FEB87	5.10	744	41	0.00500	0.0750	0.050	0.370	.0025	0.0100	1.900	.00350	0.020
JUN87	5.00	100	34	0.00750	0.0030	0.050	0.810	.0025	0.0100	0.070	.00050	0.020
SEP87	5.20	48	32	0.00150	0.0050	0.100	0.780	.0025	0.0100	0.160	.00050	0.005
NOV87	5.20	56	34	0.00500	0.0025	0.050	0.920	.0025	0.0100	0.030	.00015	0.001
MAR88	5.70	60	30	0.00500	0.0025	0.050	0.840	.0025	0.0100	0.040	.00050	0.005
NOV89	5.85	51	71	0.00500	0.0050	0.260	6.000	.0010	0.0100	22.800	.00010	1.070
MAY90	6.50	170	46	0.00250	0.0025	0.033	4.130	.0025	0.0150	9.510	.00010	.
DEC90	4.90	144	45	0.00500	0.0050	0.250	1.800	.0025	0.0100	7.200	.00025	0.660
MAY91	6.08	43	50	0.00500	0.0250	0.160	3.520	.0050	0.0800	68.000	.00100	0.570
OCT91	6.16	78	42	0.25000	0.0750	0.270	4.970	.0050	0.0700	73.800	.00150	0.820
MAY92	5.00	53	51	0.00500	0.0025	.	2.000	.0025	0.0100	13.000	.00025	0.310
NOV92	4.80	85	41	0.00500	0.0025	0.100	2.000	.0025	0.0050	6.600	.00025	0.130
MAY93	5.35	48	27	0.25000	0.0050	0.100	1.600	.0050	0.0250	3.100	.00100	0.070
NOV93	5.68	38	41	0.02500	0.0050	0.100	2.500	.0050	0.0250	31.000	.00100	0.120
MAY94	6.10	20	34	0.00250	0.0005	0.300	2.217	.0005	0.0025	0.075	.00010	0.005
NOV94	6.30	48	34	0.00250	0.0050	0.008	2.005	.0020	0.0025	1.441	.00010	0.029

DATE	Sodium	Nickel	Lead	Selenium	Chloride	Fluoride	Nitrite	Total Phenols	Sulfate	Total Organic Carbon	Total Organic Halogens
JUL83	.	.	0.0250	0.0250	0.50	0.25	0.7200	0.02500	32.0	2.80	0.190
MAY86	8.200	0.015	0.0200	0.0005	1.00	0.13	0.0025	0.00500	22.0	4.30	0.021
DEC86	4.300	0.010	0.0150	0.0025	0.80	0.33	0.0025	0.00500	1.0	1.50	1.880
FEB87	4.100	0.015	0.0150	0.0010	0.25	0.11	0.0025	0.00500	10.0	5.90	0.078
JUN87	1.500	0.015	0.0150	0.0010	1.50	0.05	0.0025	0.00500	11.0	0.50	0.070
SEP87	2.200	0.015	0.0150	0.0025	9.50	0.10	0.0025	0.00500	6.0	2.60	0.032
NOV87	2.100	0.015	0.0150	0.0010	7.00	0.05	0.0025	0.04000	2.5	0.50	0.013
MAR88	2.100	0.015	0.0150	0.0010	4.00	0.05	0.0025	0.00500	2.5	1.50	0.008
NOV89	8.580	0.010	28.4000	0.0050	0.50	0.03	0.0500	0.00250	18.0	6.00	13.700
MAY90	2.020	0.025	0.0150	0.0100	0.50	0.07	0.0600	0.00025	19.0	2.00	0.204
DEC90	2.400	0.015	0.0150	0.0030	4.00	0.05	0.0025	0.00500	23.0	39.00	0.016
MAY91	3.570	0.015	0.0500	0.0250	0.65	0.05	0.0700	0.00500	12.7	2.00	0.005
OCT91	3.430	0.060	0.0400	0.0150	0.50	0.05	0.0050	0.00500	17.0	2.50	0.005
MAY92	3.000	0.015	0.0060	0.0025	0.50	0.05	.	0.00250	15.0	1.10	0.005
NOV92	2.600	0.030	0.0003	0.0025	1.10	0.05	0.0300	0.00250	14.0	2.80	0.020
MAY93	4.300	0.020	0.0250	0.0050	1.00	0.05	0.0100	0.02500	12.0	0.25	.
NOV93	2.500	0.020	0.0300	0.0050	0.50	0.05	0.0100	0.01400	0.5	0.30	.
MAY94	1.700	0.003	0.0100	0.0010	0.50	0.25	0.0100	3.00000	1.3	0.50	0.012
NOV94	1.904	0.003	0.0100	0.0050	2.70	0.25	0.0100	3.00000	2.9	2.50	0.054

APPENDIX J

PROPOSED FIELD SAMPLING AND ANALYSIS PLAN

SECTION J.1

INTRODUCTION

This Field Sampling and Analysis Plan (FSAP) has been developed for the additional investigation activities to be conducted at the Champion's Landfill Number 6. The purpose of this plan is to identify the specific field investigation and the sampling and analysis procedures that will be used during the field activities at the Canton Landfill. These procedures are based upon the recommendation outlined in Section 7 of this report, and should be used concurrently with the Health and Safety Plan (HASP) that have been developed by WESTON for the Landfill Number 6 program.

SECTION J.2

FIELD ACTIVITIES

Field activities for the Canton Landfill investigation program are listed below and detailed in subsequent portions of the section.

- Soil Boring and Sampling Procedures.
- Borehole Geophysical Logging.
- Monitoring well installation.
- Water level measurement.
- Topographic Survey.
- Pumping Test.
- Groundwater sampling.
- Surface water sampling.

J.2.1 SOIL BORING AND SAMPLING PROCEDURES

Soil borings will be advanced during the investigation to facilitate installation of groundwater monitoring wells and temporary groundwater observation points. It is anticipated that all newly installed wells will be constructed to intersect saturated bedrock. If, however, sufficient groundwater is observed in the soil overburden, then a shallow well will also be constructed adjacent to the bedrock well. Shallow soil borings for wells will be advanced using hollow-stem augers without the use of drilling fluids. Split-spoon samples will be collected continuously to bedrock for descriptive purposes. Bedrock borings will be advanced using conventional air rotary drilling methods. Air rotary drill cuttings will be collected continuously for descriptive purposes.

Lithology will be described following the Unified Soil Classification System (USCS). The soils will be visually classified by WESTON's on-site geologist following WESTON standard operating practices (SOPs) for borehole logging and recorded in the field log book and a WESTON Geolis$_{TM}$ Borehole Log. The description will include, but not be limited to, the following:

- Soil/Rock type.
- Principal mineral composition.
- Grain size.
- Texture.
- Color.
- Minor constituents, if present, and approximate proportion.
- Plasticity for cohesive soils; plastic (PL), nonplastic (NP).
- Relative density of noncohesive and cohesive soils.
- Moisture content.
- Any structures present (bedding, foliation, fracturing, secondary porosity).

It is anticipated that drilling operations will be performed using Level D personal protective equipment.

J.2.2 BOREHOLE GEOPHYSICAL LOGGING

Once a borehole has been advanced to depth in bedrock the borehole will be logged using one or more geophysical logging techniques. One or more bedrock wells at the site may be logged depending on the quality of information gathered from the first well logged. Attachment A discusses in more detail the borehole geophysical logging objectives and procedures.

J.2.3 MONITORING WELL INSTALLATION

Bedrock monitoring wells will be constructed using air rotary drilling methods. Assuming that saturated overburden is not encountered above an aquitard separating a lower hydrologic unit, the borehole will be advanced into the bedrock to depth and a 4-inch diameter well casing and screen will be placed in the annulus. Construction will take place in the open rock borehole. If necessary, augers will be left in place in the overburden to prevent collapse of the overburden soils during well construction. A ten foot long well screen will be placed to intersect the groundwater table and penetrate approximately eight feet below the first water bearing rock. A sand pack will be placed around the well screen and will be extended approximately two feet above the screen. A two-foot thick bentonite seal will be placed above the sand pack using bentonite pellets and hydrated with potable water. Following hydration of the seal, a 5 percent bentonite/portland cement grout will be tremmied into place above the seal to the surface. Once the grout has hardened, a flush mount vault box or stick up box will be installed, at Champions discretion. If a vault box is installed, a locking water-tight cap will be secured to the riser. Monitoring well construction will be documented in the field log book and on a standard well completion form.

If first groundwater is encountered in the unconsolidated overburden, a shallow monitor well will be installed using hollow stem auger methods. The inside diameter of the auger will be at least 4 inches larger than the well screen and casing. The screens will be 10 feet in length and set 2 feet above and 8 feet below first saturated sediments. The wells will consist of 4-inch Schedule 40 PVC, No. 10 slot screen, and casing. The annular space around the screen will be backfilled as the augers are withdrawn with clean No. 2 grade sand to one foot (minimum) above the top of the screen. A seal consisting of 2 foot (minimum) of bentonite pellets hydrated with potable water will be placed above the top of the sand pack followed by a 5% bentonite/cement grout to the surface. The well will be completed as described for the bedrock wells.

If an aquitard is encountered which appears to separate two distinct hydrologic units, dual cased well construction will be required. Based on the current understanding of the site, such conditions do not appear to be present. If these conditions are encountered, additional materials will be required as well as additional equipment, thereby requiring a remobilization. Construction would require the use of large diameter augers to drill down to the aquitard. Upon reaching the aquitard, an outer 8-inch diameter PVC casing will be set into the aquitard, and the annular space between the outer casing and the borehole wall will be grouted using a 5% bentonite/cement grout. The grout will be allowed to set for 12 hours, after which time drilling will proceed through the outer

casing, using air rotary methods, until reaching the desired depth. Construction will proceed as described for the bedrock wells.

Temporary groundwater observation points will be installed at the site. Drilling and installation will be as described for the bedrock monitor wells, except that 2-inch diameter PVC construction materials will be employed.

J.2.4 WELL AND OBSERVATION POINT DEVELOPMENT

Development will be performed using a decontaminated stainless steel submersible pump no earlier than 12 hours after installation of the well. The pump will be decontaminated between wells. All wells will be pumped continuously for a minimum of three to a maximum of five saturated borehole volumes. If a well pumps dry, it will be pumped intermittently and developed to the extent practical.

Groundwater pH, temperature, and specific conductance will be measured at regular intervals (each calculated well volume, minimum) during development depending on the wells ability to produce water. Well development will continue until these readings are consistent, or until the maximum of five saturated borehole volumes have been removed. Consistent measurements are defined as $\pm$ 10% mmhos/cm, for specific conductance, $\pm$ 0.1 pH units and $\pm$ 1°C temperature.

J.2.5 TOPOGRAPHIC SURVEY

The location of each new monitoring well and temporary groundwater observation point will be topographically surveyed by a North Carolina-licensed surveyor and its map coordinates will be determined to within $\pm$0.1 feet. Elevations for the natural ground surface adjacent to the monitor well will be established to within $\pm$0.01 feet using the most recent available National Geodetic Vertical Datum. Elevations of the highest point on the rim of the uncapped well casing (not protective casing) for each monitor well will be established to within $\pm$0.01 feet using the National Geodetic Vertical Datum.

J.2.6 WATER LEVEL MEASUREMENT

At least one round of synoptic groundwater level measurements will be recorded to the nearest 0.01 foot in all wells using an electronic water level probe, in order to obtain groundwater levels characteristic of the site. Measurements will be taken from the surveyed reference point marked on the top of the PVC risers. Measurements will be recorded in the field notebook.

J.2.7 AQUIFER TESTING

The purpose of conducting pumping tests is to develop estimates of the bulk hydraulic properties of water-bearing soils and rocks. Groundwater flow varies in space and time depending on the hydraulic properties of the saturated, porous, or fractured media and the boundary conditions imposed on the groundwater system. In general, pumping tests provide results that are more representative of average aquifer characteristics than those estimated from slug tests.

Aquifer characteristics that will be obtained from the pumping test include hydraulic conductivity, transmissivity, and specific yield. The presence and position of recharge or impermeable boundaries may also be identified. These parameters can be determined by graphical solutions and computerized programs.

A four-phase pumping test is anticipated for the site: background monitoring, a step drawdown test, a constant rate test, and a recovery test. Subsequent portions of this subsection detail each phase of the pumping test.

J.2.7.1 Background Monitoring (Background Phase)

Prior to the pumping test, pretest background water levels will be monitored for 12 at the observation wells and the well to be pumped. Water level measurements will be obtained using pressure transducers connected to an automatic electronic data logger. The procedure used to perform background water level monitoring is as follows:

- Take an initial water level measurement in each well with a water level indicator. Record the depth to water and the well reference point used (e.g., top of inner casing) in the logbook.

- Plumb depth to bottom of each well with a water level probe. Record this measurement in the logbook.

- Unpack data logging equipment. Check the operation of the data logging equipment. Record the results of the equipment check in the logbook. Ensure proper de-contamination of all equipment.

- Pad the edge of both the inner and outer well casings in each well to protect the transducer cables.

- Measure a length of transducer cable sufficient to lower a transducer to a point a minimum of 10 feet below the water level measured in each observation well. For observation wells, the transducer should not at any time be lowered to a depth that is less than 1 foot above the measured bottom of the well. For the pumping well, if a Grundfos Ready Flow-2 pump is used, a special transducer must be used in the pumping well to avoid electrical interference of the transducer's signal.

- Securely tape the transducer cable to the outside of the protective casing of each well with duct tape.

- Set the pump into the well near the base of the well, keeping the pump at least one foot away from the transducer. Secure the pump.

- Place a clean cover on the well, especially when rain is expected.

- Connect all transducers to the data logger and note in the logbook which channel is connected to which well.

- Enter the required information into the electronic data logger and record in the log. The type of information may vary, depending on the model. The following information generally must be entered:

  - Well ID.
  - Test number.
  - Date and time.
  - Scale factors and serial numbers for each transducer.
  - Initial water levels.
  - Water level sampling rate.

- Where appropriate, record changes in atmospheric pressure and precipitation during the test. The Project Hydrogeologist will determine whether these data are required.

- Start data logger and collect background water levels for the designated period of time.

The background monitoring phase can be performed after the step drawdown test if warranted by the field schedule. If this occurs, it is important to complete the recovery phase of the drawdown test before beginning the background monitoring phase (i.e., wait 24 hours or until water levels return to 90% of the pretest static level before commencing background monitoring).

J.2.7.2 Step Drawdown Test

The step drawdown test allows the calculation of some of the hydraulic properties of the aquifer being tested, such as well efficiency, specific capacity, and a preliminary estimate of aquifer transmissivity. The step drawdown test is also used to estimate the full-capacity discharge rate of the well so that a suitable constant discharge rate can be set for the later constant-rate pumping phase of the aquifer test. The step drawdown test consists of collecting water level and discharge data for the pumping well during a minimum of three successive periods of pumping at constant rates. The following procedure is used to conduct a step drawdown test:

- Measure the water levels in each of the observation wells and in the designated pumping well. Record the measurements in the logbook.

- Reset the data logger by entering new water levels and a new data collection rate. The data collection rate will be determined by the Project Hydrogeologist.

- Prepare to start the pump by pre-setting the discharge rate to a low value. Note the flow rate meter total discharge reading and time.

- Start the data logger and then immediately start the pump.

- Measure the discharge rate of the pump by taking three to five successive measurements using a suitably sized container and stopwatch, and read the measurements from the flow meter. Record these rates in the logbook. Early in the test it is necessary to take discharge measurements every 2 to 3 minutes. Once the pumping rate has stabilized, discharge measurements can be checked less frequently. Record data in the logbook.

- Run the test until the water level in the pumping well reaches stabilization (e.g., 0.25 foot of drawdown during a 15-minute period).

- When stabilization is reached, step the data logger, and increase the discharge rate from the pumping well. Note the flow rate meter total discharge reading and time. Take discharge measurements as specified previously. Monitor as discussed for the initial step. Repeat procedure until all desired steps have been completed.

- Carefully monitor water level data in the pumping well. If it appears that the well will pump dry, close the valve to a point at which it appears that the discharge rate is equal to the maximum well capacity. Do not allow the water level to drop below the level of the pump intake.

- Turn off the pump and note the flow rate meter total discharge reading and time. Collect water level recovery data until the start of the pumping test phase.

- Wait 24 hours or until water levels return to 90% of their prestep drawdown test levels before commencing with the next test.

J.2.7.3 Constant Rate Test (Drawdown Phase)

The next part of the pumping test is the drawdown phase. The duration of this phase of the test is determined by the needs of the project and the aquifer properties.

The following procedure is used to perform the constant rate pumping test:

- Stop the data logger from taking recovery data from the step drawdown test just completed after 90% of pretest static water level has been attained.

- Measure the water levels in each of the wells. Record the measurements in the logbook.

- Reset the data logger by entering new water levels (if necessary) and a new data collection rate.

- Prepare to start the pump at the discharge rate determined from the step drawdown test.

- Start the data logger and then immediately start the pump.

- Measure the discharge rate of the pump by taking three to five successive measurements using a suitably sized container and a stopwatch, and read the measurements from the flow meter. The discharge rate must be kept constant throughout the pumping test. At the start of the test, discharge rates can vary considerably so discharge measurements must be taken at 1- to 3-minute intervals. Once the discharge rate has stabilized, measurements can be taken less frequently. Adjust the discharge rate as necessary. Record discharge measurements and time of adjustments in the logbook.

- Periodically manually measure and record water levels in all wells being monitored. Manual water level measurements are important in verifying the proper operation of the transducers during the test. Record the water level measurements in the logbook.

- Continue pumping at a constant discharge rate for the duration determined by the Project Hydrogeologist prior to the test.

J.2.7.4 Recovery Test (Recovery Phase)

A recovery test will be conducted as part of the aquifer testing. The procedure for the recovery test is as follows:

- At the predetermined termination time of the constant rate test, step the data logger to obtain recovery water level data and immediately stop the pump. Note the total volume of discharge water recorded on the flow rate meter.

- Using the data logger, measure the water levels in all wells until they recover to approximately 90% of the static water level measured at the start of the pumping test.

- Stop the data logger operation; remove and decontaminate all equipment from each of the wells. Secure the wells.

- Using a portable computer, download the data from the pumping test.

J.2.8 GROUNDWATER SAMPLING

Groundwater sampling will be accomplished only after the wells have been properly developed and purged. Monitor well purging and groundwater sampling will occur no earlier than 7 days after well development has been completed.

Procedures for sampling monitor wells are as follow:

- Water level measurements will be taken to the nearest 0.01 foot with respect to the established survey point on top of the well casing. All measuring devices used in the well will be thoroughly rinsed with distilled water prior to reuse. The depth to the top of the water will be subtracted from the total casing depth to determine the height and, subsequently, the volume of standing water in the casing.

- To ensure collection of samples representative of groundwater quality, a submersible pump or bailer will be used to remove a minimum of three calculated well volumes, unless the well is purged dry. Well purging will be considered complete when pH, conductivity and temperature are consistent as defined by +/- 0.1 pH unit, +/- 10% conductivity, and +/- 1° Celsius (with a minimum of three measurements taken, each separated by at least 10% of one well volume), or when a maximum of five well volumes have been removed. If the well is pumped or bailed dry, it will be allowed to recover for 15 minutes, and then purged dry again, to complete the purge. During purging of the monitoring well, groundwater, pH, specific conductance, and temperature will be recorded in the logbook.

- Samples will be obtained using a disposable polyethylene bailer. Samples will be collected for total metals, Phenol, TOX, TOC, NO_2, NO_3, Cl, fl, SO_4,, TDS, pH, and specific conductance. All samples from the well will be collected within 8 hours of the purge, unless slow recovery does not provide enough volume.

- Groundwater samples collected for total metals will not be field filtered and will be preserved with nitric acid.

- All samples for chemical analyses will be placed in laboratory-prepared bottles (see Subsection J.3). Sample bottles will be labeled with an indelible marker, recording the well location, sample date, time, analysis, and preservative. Sample bottles will then be placed in plastic resealable bags to guard against any bottle leakage during shipment and placed in an insulated cooler chest surrounded by ice and packing material.

All nonexpendable sampling equipment (submersible pumps and polyethylene effluent hose) will be decontaminated after sampling to reduce the opportunity for cross-contamination between wells. Bailer line will consist of high-test monofilament line and will be discarded after use at a given well. Disposable sample bailers will be discarded after use at a given well.

J.2.9 SURFACE WATER SAMPLING

Standing downstream of the sample locations, the sampler will fully immerse the appropriately sized sample bottle in the water such that the bottle is filled. The bottle shall then be closed, wiped

dry, and labeled. Surface water samples collected will not be field-filtered before being preserved with nitric acid.

Labels will be filled out with waterproof ink, attached to the sample container, recording the well location, sampling time, data, analysis, and preservative, if any, sample bottles will then be placed in plastic resealable bags and stored in insulated coolers containing ice and packing materials.

J.2.10 SAMPLE DOCUMENTATION IN THE FIELD

Four kinds of documentation will be used in tracking and shipping analytical samples:

- Bound field logbook.
- Standardized data recording forms.
- Sample labels.
- Chain-of-custody records.

At a minimum, the label for each sample container will contain the following information:

- Site name.
- Sample number.
- Date and time of collection.
- Sampler's initials.
- Sample preservation and preservative used.
- Type(s) of analyses to be conducted.

The sample information, as well as the analyses to be performed on the sample, will be entered in the field logbook for each sampling point. If an error is entered into the field log, a single line will be drawn through the error and initialed by the person completing the log. All entries into the sample log, data recording forms, chain-of-custody, sample labels, etc. will be made using an indelible ink pen.

Additionally, the following items will be entered into the field logbook:

- Dates and times of entry.
- Sample depth and number.
- Names of field personnel on-site.
- Names of visitors on-site.
- Field conditions.
- Description of activities.
- Sampling remarks and observations.
- QA/QC samples collected.
- List of photographs taken.
- Sketch of site conditions.

J.2.11 SAMPLE HANDLING AND TRANSPORTATION

All samples will be kept on ice from the time of collection and forwarded on a daily basis to the laboratory by the on-site geologist. Custody of the samples will be maintained by WESTON personnel from the time of sampling until the time they are forwarded to Hydrologic, Incorporated, the analytical laboratory.

Documentation of the sample custody will be maintained on a standard chain-of-custody (COC) record. The following information will be entered onto he COC record.

- Project name.
- Signature of sampler.
- WESTON sample number, date, and time of collection, grab or composite sample designation, and sample media.
- Signatures of individuals involved in sampler transfer.

WESTON field personnel will complete a COC record to accompany each cooler forwarded from the site to the laboratory. Coolers will be hand delivered to the Hydrologic, Inc. If an error is entered onto a COC record, a line will be drawn through the error and initialed by the person completing the form. The original copy will be placed in a sealable bag and put inside the appropriate cooler, secured to the cooler's lid. The laboratory sample custodian, or his/her representative accepting the sample shipment, will sign and date the COC record upon sample receipt. The original COC record will be returned with the final data report. The laboratory will be responsible for maintaining internal logbooks and records that provide a custody record during sample preparation and analysis.

J.2.12 DECONTAMINATION PROCEDURES

All material and equipment will arrive on-site in a clean condition. Recommended procedures for equipment decontamination, as described in the following subsections, will be followed, where applicable.

J.2.12.1 Drilling and Monitor Well Installation Equipment Decontamination

Prior to the start and in between sample locations of drilling, all down-hole drilling equipment will be steam cleaned. Split-spoons will be cleaned by steam cleaning or by scrubbing in a solution of potable water and Alconox (a laboratory detergent), and rinsed in potable water. Augers, tools, drill rods, casings, and screens will be visually inspected to after decontamination and before use to confirm that any residues have been removed. Similar decontamination procedures will be implemented between each boring to minimize the opportunity for cross-contamination.

J.2.12.2 Well Development Equipment Decontamination

Submersible pumps and polyethylene tubing used for well development will be decontaminated between wells. Pumps will be decontaminated by externally scrubbing with a natural bristle brush and internally flushed in a solution of potable water and Alconox, followed by a potable water rinse and flush.

J.2.12.3 Water Level Measurement Equipment Decontamination

Water level indicators used in the wells will be decontaminated by thoroughly rinsing in commercially available distilled water.

J.2.12.4 Water Sampling Equipment Decontamination

Pumps used for well purging will be decontaminated as described above for pumps used for development. Disposable bailers will be used at each well, and will be discarded after use at a given well. New, clean monofilament line will be used to tether the bailers, and will be discarded after use at a given well.

SECTION J.3

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, HOLDING TIMES, AND SAMPLE VOLUMES

All samples submitted for analysis on this project will be collected by WESTON personnel. Sampling containers and preservatives will be provided by the laboratory (Hydrologic Inc.). The specific requirements for sample containers, preservatives, and analytical holding times are discussed in the following subsections and are listed in Table J.3-1.

The laboratory will follow the QA/QC requirements in accordance with the State of North Carolina DEHNR guidelines and applicable EPA guidelines. The laboratory will follow the procedures as described in the applicable guidelines in determining laboratory QA/QC requirements, including but not limited to laboratory duplicates, reagent and method blanks, and matrix spike duplicate samples. Holding time requirements as required by the appropriate analytical method will be identified and samples will be analyzed within that time frame. Attachment B presents the QA/QC program for Hydrologic Laboratories, Incorporated (the laboratory providing analytical services for the current monitoring program).

Table J.3-1
Summary of Sample Container Specifications, Preservatives, and Holding Times
Groundwater/Surface Water

Analyte	Minimum Sample Volume	Preservative	Holding Time
Total Metals[1]	1L polyethylene with polyethylene lined closure	HNO_3 to pH <2 Cool, 4°C	6 months (Hg 28 days)
Phenol	1L amber glass with telfon lined closure	H_2SO_4 to pH <2 Cool 4°C	28 days
TOX/TOC	1L polyethylene with polyethylene lined closure	H_2SO_4 to pH <2 Cool, 4°C	28 days
NO2, NO3, Cl, Fl, SO4, TDS, pH, Conductivity	1L polyethylene with polyethylene lined closure	H_2SO_4 to pH <12 Cool, 4°C	28 days, pH upon receipt

Notes:
1 Metals include: iron, potassium, lead, magnesium, manganese, nickel, selenium sodium, zinc, mercury, silver, arsenic, barium, cadmium,calcium, chromium and copper.

SECTION J.4

SITE MANAGEMENT

The basic components of site management in support of the planned field activities are described in the following subsections.

J.4.1 GENERAL OPERATIONS AND COORDINATION WITH CHAMPION

At the beginning of the project, a member of Champion's staff will be designated as the site point of contact (POC). All coordination with other parties on station will be performed by WESTON through the POC. All contacts from outside parties concerning the project will be made through the POC.

The Site Geologist will be responsible for day-to-day coordination of WESTON field teams and subcontractors as well as day-to-day contact with the POC. The project Hydrogeologist will be responsible for the overall design, execution and analysis of the pumping test field and office effort. The POC will be responsible for arranging for personnel and vehicle passes for WESTON and subcontractor personnel, and general coordination issues associated with Champion operations.

For each field activity involving more than one person, a Field Team Leader will be designated by the Site Geologist in agreement with the Project Manager from among the WESTON personnel present on station. The Field Team Leader will be responsible for coordinating the activities of his/her team, including subcontractors, and for notifying the Site Geologist of progress and/or logistical problems.

J.4.2 SITE ACCESS AND SECURITY

Field work will be performed within the boundaries of Landfill Number 6. Travel within site boundaries is restricted to authorized personnel.

During actual field operations, access to working areas will be limited to WESTON and subcontractor personnel and visitors authorized by the POC. All visitors will be requested to keep clear of field activities. If the presence of visitors creates a situation perceived by the WESTON Field Team Leader as dangerous, all work will be terminated until appropriate working conditions can be restored. If necessary, the Field Team Leader will notify the Site Geologist, who will notify the POC.

J.4.3 SITE LOGISTICS

Potable water for field operations will be obtained from on-site drinking water sources to be specified by the POC.

Decontamination of drilling and sampling equipment will be performed at each work site (for small equipment), or (for large equipment) at a centralized decontamination area to be designated by the POC. All decontamination will be performed using water from the site potable supply, except where distilled water is specified.

Electricity for remote field operations will be provided from portable generators to be supplied by either WESTON or WESTON's drilling subcontractor.

ATTACHMENT A

BEDROCK WELL GEOPHYSICAL SURVEY

ATTACHMENT A

BEDROCK WELL GEOPHYSICAL SURVEY

1.0 INTRODUCTION

Monitor well boreholes at Landfill Number 6 will be advanced into bedrock using conventional air rotary drilling. Once the borehole has been advanced to an appropriate depth (an estimated 10- feet into water bearing bedrock), the open borehole will be evaluated using one or more downhole geophysical techniques. Downhole geophysics will be used to gathered information on fracture orientation and density in one or more selected bedrock wells, in order to assess the influence of bedrock fractures on groundwater movement. Information on the physical properties of the bedrock may also be gathered to support field logging observations.

One or more logging techniques will be used during the geophysical logging portion of the field investigation, depending on bedrock encountered, time constraints, and equipment availability. Caliper logging will be conducted first to determine if any fractures are present in the borehole and to document borehole diameter. A temperature log will also be completed. Both the caliper and temperature logs are run in part to facilitate in field equipment calibration as part of the in-field data quality control. Additionally, the effects of borehole diameter changes need to be anticipated as electric logs generally respond not only to lithologic and structural changes, but also to borehole diameter changes. The following sections describe the basic principles of operation of each of the geophysical (electric) logs available for use as needed during the investigation and the typical response observed on each log.

- **Natural Gamma Log** - The gamma log provides a continuous record of the amount of natural gamma radiation emitted by the formations penetrated by a borehole. In general, the gamma activity of clay-bearing sediments and rocks (e.g., clays and shales) is much higher than that of quartz sands or sandstones. Naturally occurring gamma-emitting radioisotopes, such as potassium-40 and daughter products of the uranium and thorium decay series, are generally concentrated in clay. The gamma ray probe detects gamma radiation through the use of a passive sodium iodide crystal and scintillation counter. The greater the counting rate, the more events the gamma detector is measuring, which, in turn, corresponds to a higher clay content of the surrounding strata. The gamma tool is run to the bottom of the borehole and recorded at a constant logging speed from the bottom to the top of the well. Typically, several logging suites will be conducted using natural gamma detectors. The objective is to ensure good repeatability of the gamma response to serve as a depth reference check on the other logging probes.

- **Resistivity Log** - The resistivity log measures the electrical resistance (in ohms) of the earth materials lying within the well between two electrodes on the probe. Increases in formation resistance produce corresponding increases in resistivity on the log. In general, the resistivity log response in resistive rocks (sandstones) and conductive rocks (shales) provides a mirror image of the gamma log under suitable conditions. Because a constant electric current is

generated between the two electrodes on the resistivity tool, the log requires a borehole fluid to conduct the current. In addition, the resistivity tool cannot read the resistance of a formation through casings. As a result, the resistivity tool is run from the bottom to the top of the fluid column in the open-hole wells at a constant logging speed. Repeat electric logs are run in each well as a quality control check on whether electrical interference occur as the result of anthropogenic or man-made sources (power lines).

- **Spontaneous Potential (SP)** - The SP log is used to measure variations in the natural electrical potential within the borehole. This potential, measured in millivolts, results from one of three principal causes: (1) electro-chemical potential resulting from a contrast between the resistivities of the borehole fluid and the formation pore water, (2) redox potential or the oxidation/reduction of sulfide mineralization such as pyrite, and (3) electro-mechanical potential or streaming potential caused by fluid flow directly into or out of the wellbore. This log has limited use in fresh water environments where salinity differences between the borehole fluid and formation water are typically negligible.

- **Electro-Magnetic Resistivity Log** - The E.M. Resistivity tool uses a magnetic field to induce an electric field which in turn produces electric currents in the material being surveyed. The tool then measures the conductivity and magnetic susceptibility of the material around the probe. The resultant log is displayed as both conductivity and resistivity curves. Interpreted in conjunction with the natural gamma log, resistive formations (sandstones) and conductive formations (shales) can be readily identified. The advantage of the E.M. Resistivity tool is that it can see through both steel and PVC casings and does not require a fluid-filled borehole like conventional electric logs

ATTACHMENT B

LABORATORY QA/QC PROGRAM

HYDROLOGIC, INC.

Quality Control/ Quality Assurance Documentation

of

The Asheville Laboratory Group

and

The Frankfort Laboratory Group

HYDROLOGIC, INC.

Analytical Procedures

ASHEVILLE LABORATORY

HYDROLOGIC, INC.

Analytical Procedure

Title: Alkalinity - Titrametric	
Date Issued: 2 February 1993	Supercedes:
Issued by:	

Safety:

Lab coat
Safety glasses

Equipment:

pH meter
Stir plate with stir bars
Buret 50 ml
Pipets (various sizes)
Beaker 250 ml

Reagents:

0.1 N Sulfuric acid (H_2SO_4) Ricca cat. #2550-1
0.02 N Sulfuric acid (H_2SO_4) *Preparation:* To a 500 ml volumetric flask transfer 100.0 ml of 0.1 N H2SO4. Dilute to volume with deionized water. Shake to mix.
0.02 N Sodium carbonate reagent (Na_2CO_3) *Preparation:* Dry a quantity of anhydrous Na_2CO_3 at 110°C for three hours. Weigh to the nearest 0.1 mg 1.060 g of dried Na_2CO_3. Quantitatively transfer to a 1000 ml volumetric flask. Add sufficient water to dissolve. Then dilute to volume with deionized water. Shake to mix.
pH 4 Buffer Ricca cat. # 1501
pH 7 Buffer Ricca cat. #1551
pH 9 Buffer Banco cat. #16450
Performance standard of known concentration

Procedure:

Standardize pH meter according to the pH procedure
0.02 N H_2SO_4 Standardization
Standardize 0.02 N H_2SO_4 as described in Total Kjeldhal Procedure (pg 2 of 3). Calculate (see calculation section) and record normality of H_2SO_4.
Sample Determination:
Transfer 200.0 ml of sample to a 250 ml beaker.
Submerse the pH electrodes in the solution and start agitation.
Record initial pH.
Slowly titrate the solution with standard 0.02 N H_2SO_4 to pH 4.3 to 4.7. Care must be exercised with the addition of H_2SO_4 so as

not to overshoot the target pH range. Allow sufficient time for the pH to equilibrate between H_2SO_4 additions.
When the solution is between pH 4.3 and 4.7 stop titrating and record the volume of 0.02 N H_2SO_4 required. Record the intermediate pH.
Carefully add sufficient standard 0.02 N H_2SO_4 to reduce the pH an additional 0.30 units. Record the volume required and the final pH.
Calculate (see calculation section) the alkalinity of the sample as ppm $CaCO_3$.

Calculation:

Standardization

$$N\ H_2SO_4 = \frac{(N\ Na_2CO_3) \times (vol\ Na_2CO_3)}{vol\ of\ H2SO4}$$

Sample determination:

$$\text{Total alkalinity (ppm } CaCO_3) = \frac{(2B\text{-}C) \times N\ H_2SO_4 \times 50{,}000}{\text{Sample vol (ml)}}$$

Quality Control:

Sample for alkalinity should be preserved cooling to 4°C at the time of collection. Samples must be analyzed within 14 days of collection.
The 0.02 N H_2SO_4 is standardized with each analytical session.
Duplicate analysis are performed at a rate of not less than 10%.
A performance standard of known concentration is run with each analytical session. The value obtained should be within +10% of the vendor's published value. If not, contact the supervisor.
All standardizations and solutions preparations are documented in the benchsheet notebook.
Proper sample preservation is verified at log-in.

HYDROLOGIC, INC.

Analytical Procedure

Title: Ammonia Nitrogen Determination	
Date Issued: 4 July 1994	Supercedes: 21 February 1992
Issued by:	

Safety:

Lab coat
Safety glasses

Sample Preservation:

Sample requiring ammonia nitrogen determination should be preserved at the time of collection with the addition of H_2SO_4 to pH <2 and chilling to 4°C. When residual chlorine is present, this must also be destroyed at the time of collection.

Reporting limit:

0.1 mg/L N-NH_3

Equipment:

Accumet 925 pH/ISE Meter with gas sensing electrode adaptor
Ammonia Ion Selective Electrode
Magnetic stir plate and stirring bars
Volumetric flasks as required
Beakers
pH paper
Pipets as required

Reagents:

Sodium hydroxide (10N): Prepare by dissolving 100g of reagent grade NaOH in water. Allow solution to cool (Exercise caution in dissolving NaOH in water. The heat of solution is markedly exothermic and sever burns could result.) Transfer quantitatively to a 250 ml volumetric flask. Allow to cool to room temperature and dilute to volume. Label as to contents and date prepared.
Ammonia stock solution (1000 mg/L): Prepare by: Weighing to the nearest 0.1 mg (0.0001g) 1.91 g of NH_4Cl which has been previously dried for 1 (one) hour at 104°C. Dissolve in water and transfer to a 500 ml volumetric flask. Make certain that the solution is at room temperature before diluting to volume; the heat of solution for NH_4Cl is endothermic. Label and date the flask.
Ammonia working solution (100 mg/L): Prepare by: Volumetrically pipeting 50 ml of 1000 mg/L stock solution into a 500 ml volumetric flask and diluting to volume. The working solution should be prepared fresh with each analytical session.

Ammonia standard: Prepare by: Serially diluting successive volumes of ammonia working solution (100 mg/L) to produce standards which are 10.0 mg/L, 5.0 mg/L, 1.0 mg/L, and 0.1 mg/L in ammonia nitrogen respectively.

Procedure:

Instrument standardization:

Transfer the 10 mg/L standard to a 250 ml beaker, immerse the electrode in the solution, and begin moderate agitation by means of a stir bar. Care should be taken to avoid sucking air bubbles into the sample. Should this occur, reduce the stirring speed and repeat the determination (standard or sample which ever is applicable.)
Add 1 ml of 10N NaOH.
Switch the ISE meter to concentration mode by depressing the "MODE" key until concentration appears in the prompt screen.
Depress the "STBY/MEAS" key. Depress the "MULTI-POINT CAL" key and at the prompt depress the 3 key and then the "ENTER" key. This manipulation need only be performed prior to standardizing on the first standard.
As prompted enter the concentration of the standard.
Allow the measurement to come to equilibrium (typically 4 or 5 stars) and depress the "ENTER" key. Record the equilibrium millivolts of the standard on the benchsheet.
Repeat this process for the 5.0 mg/L and 1.0 mg/L standard making sure to properly enter the standard concentration.
After completing the standardization the efficiency must be between -0.90 and -1.10. Failure to achieve this efficiency requires restandardization of the instrument. If after the second attempt the instrument efficiency does not meet the requirements, consult the supervisor.

Sample Determination:

Verify the calibration by running a reagent blank, followed by the lower detection limit standard (0.1 mg/L $N\text{-}NH_3$), the linearity check standard (5.0 mg/L $N\text{-}NH_3$) and finally an APG standard. These verifications are determined according to the sample determination procedure given below. Determine the % recovery of each standard as outlined in the Calculation section of this document. Acceptance criteria are outlined in the Quality Control section of this document.
Transfer a 100 ml representative aliquote of sample to a beaker.
Immerse the electrode in the sample solution and with agitation add 1 ml of 10N NaOH. Verify pH by means of pH paper. If the pH is above 11 add additional 1 ml aliquotes of NaOH until the

pH is above 11. Typically 1 ml is sufficient.
Depress the "STBY/MEAS" key. When a stable reading is obtained record the concentration on the benchsheet.
Remove the electrode, rinse and blot dry.
Repeat this procedure for each successive sample.
Should a sample produce a concentration greater than 10 mg/L, dilute the sample such that the concentration of the diluted sample is between 1.0 mg/L and 10.0 mg/L N-NH_3. Apply the appropriate dilution factor as given in the calculation. See calculation section.

Calculation:

Sample dilution:

$$\text{mg/L N-NH}_3 = \frac{\text{Obs. conc. x final volume}}{\text{Sample aliquote}}$$

Standards Recovery:

$$\text{\% Recovery} = \frac{\text{Found value}}{\text{True value}} \text{ X } 100$$

Spike Recovery:

$$\text{\% Recovery} = \frac{\text{Conc. of spiked sample - conc. of unspike sample}}{\text{Spike Concentration}} \text{ X } 100$$

Relative percent difference:

$$\text{RPD} = \frac{|(\text{Repl.1 - Repl. 2})|}{((\text{Repl. 1 + Repl. 2})/2)} \text{ X } 100$$

Quality Control:

Proper sample preservation is verified at log-in. Failure necessitates that the client be notified. If the client persists in having the sample run, NCDEHNR must be notified. Preservation violations are noted on the benchsheet.
Instrument efficiency must be -0.90 to -1.10. Failure requires restandardization.
The standard curve is verified immediately after standardization by running a lower detection limit, LDL, standard (0.1 mg/L), a

linearity check standard, LCS, (5.0 mg/L), and an APG standard. Acceptable recoveries are ±10% or within established control limits, which ever is lowest. Failure requires that the standard be rerun. See calculation section. A second failure necessitates restandardization. If the standards still fail to recover appropriately the supervisor must be consulted.

Samples are duplicated at a minimum rate of 10%. Relative percent difference for the replicates must not exceed 20% or within established control limits which ever is lowest. See calculation section. Failure requires that both replicates be rerun. A second failure requires consultation with the supervisor.

Linearity check standard (LCS) are run at a minimum rate of 10%. Acceptance is as given after initial calibration. See calculation section.

A representative number of samples are selected quarterly and a second representative aliquote distilled prior to ion selective electrode determination. The samples should agree distilled vs undistilled within 20% RPD or within the established control limits which ever is lowest. See calculation section

References:

"Methods for Chemical Analysis of Water and Wastes." Method 350.3, EPA 600-4-79-020.

"Standard Methods for the Examination of Water and Wastewater 17th Ed.," 4500-NH3F, American Public Health Association, *et.al*, 1989.

WASTERWATER SERVICES, INC.
Analytical Procedure

Title: Biological Oxygen Demand

Date issued: 19 Sept. 1990

Approved by:

SAFETY: Use of lab coat, safety glasses and gloves

EQUIPMENT: Incubator capable of maintaining 20 ± 1°C
pH meter Fisher Model 900
Dissolved oxygen probe Orion Model 97-08-00
300 ml BOD bottles
Various pipets
Dilution water carbouy 20 liter

REAGENTS: Phosphate buffer - Prepare by dissolving 8.5g of reagent grade $KH_2PO_4 . 7H_2O$, 33.4g of $Na_2HPO_4 \cdot 7H_2O$, 21.75g K_2HPO_4 and 1.7g NH_4Cl in 1 liter of water.
Magnesium sulfate solution - Prepare by dissolving 22.5g of $MgSO_4 \cdot 7H_2O$ in 1 liter of distilled water.
Calcium chloride solution - Prepare by dissolving 27.5g of $CaCl_2$ in 1 liter of distilled water.
Ferric chloride solution - Prepare by dissolving 0.25 g of $FeCl_3 \cdot 6H_2O$ in 1 liter of distilled water.
Dilution water (20 L)- Prepare by filling a carbouy with distilled water. Add 20 ml (1 ml/L) each of magnesium sulfate solution, calcium chloride solution, and ferric chloride solution. Allow the dilution water to "age" a minimum of 5 days. Just prior to use add 20 ml (1 ml/L) of phospate buffer.
Glucose-glutamic acid solution - Prepare by weighing to the nearest 0.0001g 0.150g each of glucose and glutamic acid. (These reagents must be dried prior to weighing at 103°C for a minimum for 1 hour.)
Quantitatively transfer to a 1 liter volumetric flask. Dilute to volume. This solution yields a BOD of 200 mg/l.
Sodium sulfite solution - Prepare by weighing to the nearest 0.0001g, 0.1575g of sodium sulfite (Na_2SO_3). Quantitatively transfer to a 100 ml volumetric flask and dilute to volume. This solution must be prepared fresh daily.
Managanous sulfate Reagents Cat. # 7-24305
Alkaline-iodide-azide Ricca Cat # 540
Sulfuric acid Reagents Cat # 5-10260-4

Starch solution - Prepare by dissolving 5g of soluble starch in 900 ml of boiling water. Add 1.25g of salicylic acid and dilute to 1 liter.
Sodium thiosulfate - Prepare by weighing to the nearest 0.0001g, 3.1025 g of $Na_2S_2O_3 \cdot 5H_2O$. Transfer quantitatively to a 500 ml volumetric flask. Dilute to volume. Standardize against potassium bi-iodate to a clear end point. (Add starch indicator when the $Na_2S_2O_3$ solution becomes straw yellow.) Record normality of $Na_2S_2O_3$ solution. The solution must be 0.020 N $\pm$ 0.0005, if not reprepare solution.

Procedure: Sample Pretreatment: The pH of all samples is adjusted, if necessary, to pH 6.5 - 7.5 with sulfuric acid or sodium hydroxide.
The chlorine in chlorinated samples must be neutralized. Using the volume of a sample which will be used in the dilution series, add 10 ml of 1+1 acetic acid and 10 ml of KI solution. Add starch indicator solution and mix. If the solution turns blue titrate to the clear end point with Na_2SO_3, counting the drops required to reach the end point. If the volume of Na_2SO_3 > the volume of sample the sample volume must be reduced such that the volume of Na_2SO_3 required to neutralize the chlorine does not exceed the sample volume.
Sample Dilution: Prior to diluting samples for B.O.D. perform a Winkler titration and calibrate the dissolved oxygen probe.
To a 300 ml B.O.D. bottle add the desired volume of sample. Use the following criteria to assist in selecting the proper sample volume.
-the worse a sample looks or smells the lower the dilutions
-the higher the suspended solids contained in the sample, the lower the dilution
-influent samples should always be set very low
-influent samples need not be tested for chlorine or seeded.
-seed all effluent and pretreatment samples with standardized seed.
Seed the samples as required and record the volume of seed used on the bench sheet.
Duplicate seed bottles should be prepared for the seed correction factor by adding the selected seed volume to a B.O.D. bottle, adding dilution water to 300 ml, determining the initial dissolved oxygen, and incubating with the

sample series. The final dissolved oxygen is determined as described below.
Add sufficient dilution water to bring the final volume of sample and dilution water to 300 ml.
Determine the initial dissolved oxygen of the sample using the dissolved oxygen probe. Record this value on the bench sheet.
Incubate the sample at 20 ± 1°C for five (5) days.
At the end of the five (5) day incubation period determine the final dissolved oxygen of the sample using the dissolved oxygen probe. The probe should be calibrated against the Winkler titration prior to this determination. Record the final dissolved oxygen on the bench sheet.

Calculations:

(1) initial dissolved oxygen (IDO) - final dissolved oxygen (FDO) = D.O. loss

loss - seed correction = net loss

dilution factor = 300ml/sample volume (ml)

(2) $$\text{seed correction} = \left(\frac{\text{D.O. loss in seed bottle}}{\text{vol. of seed}}\right)\left(\text{vol. of seed used}\right)$$

B.O.D.(mg/L) = net loss x dilution factor

Data Reporting: The following critera are used to select the data reported

F.D.O.	D.O. loss	Report
≥ 1	≥ 2	Calculated BOD_5 to the nearest 0.1 mg/l.
> 1	1<loss<2	Calculate BOD_5 using the dilution which gives loss closest to 2 mg/l.
< 1		Use lowest ml sample, calculate BOD_5 and report as > the calculated value

F.D.O.	D.O. loss	Report
	< 1	Calculate BOD_5 based on 0.1 mg/l D.O. loss; report as < calculated value.

Average when all dilutions have a F.D.O ≥1 mg/l and a D.O. loss ≥2 mg/l

Winkler titration: Fill two B.O.D. bottles with distilled water. Place one bottle on the dissolved oxygen probe and let the meter equilibrate.
To the other bottle add 2 ml of alkaline-iodide azide solution and 2 ml of manganous sulfate. A brown precipatate will form. Shake the bottle to suspend the precipatate. Allow the precipatate to settle until at least 3/4 of the bottle is clear. Shake the bottle again to suspend the precipatate and allow the suspension to settle out. Repeat this procedure 2 more times. The add 2 ml of H_2SO_4 and shake again. The resulting solution should be clear and yellow. By means of a 201 ml volumetric flask transfer 201 ml of this solution to a 500 ml Erlenmeyer flask. Titrate with standard $Na_2S_2O_3$ to a straw yellow color. At this point add starch indicator and continue titrating until the blue color is discharged. The volume of $Na_2S_2O_3$ required to reach the end point should be equivalent to the dissolved oxygen reading obtained from the bottle filled with distilled water and placed on the meter. If not, adjust the meter such that the D.O. reading corresponds to the volume (in ml) required for the Winkler titration.

Seed Standardization: A source for seeding B.O.D must be standardized prior to use. When a seed is secured, the sample is allowed to settle and syphoned into plastic bottles labelled exclusively for use with B.O.D. seed.
To standardize the seed a series of dilutions are prepared according to the chart below. The samples are treated as any other B.O.D. sample. That is, the sample is diluted to 300 ml, the initial D.O. determined, incubated 5 days and the final D.O. determined.

Sample volume (ml)	# of replicates
15	1
10	2
5	2
2	1
1	1
0.5	1

After the 5 day incubation period calculate the loss per ml as follows

D.O. loss/ml = D.O. loss/sample volume

The ideal value for seed correction is within the 0.6-1.0 mg/l range. Under ideal circumstances, the seed volume for the daily "seed check" is determined from the standardization yielding a D.O. depletion of 50% of the initial D.O. The seed volume for sample bottle is that volume which will theoretically produce a D.O. loss of approximately 0.8 mg/l. Often times this requires a bit of experimentation to meet these criteria.

Quality Control: A minimum of two dilutions of each sample are run for each sample. When the sample is unfamiliar three dilutions are prepared. Of the two dilutions prepared, the dilution yielding an oxygen depletion of 2 mg/L with a residual oxygen of at least 1 mg/L is reported. A minimum of one duplicate must be run with each series of samples. If more than one page of samples are set-up a duplicate per page is to be run. The seed volume is sufficient to yield a 0.6-1.0 mg/L oxygen depletion in the seed check bottles.

A standard glucose-glutamic acid solution with B.O.D. = 200 mg/L is run with each series of samples. The B.O.D. found from this solution is recorded.

An independently acquired quality control standard is run monthly. Acceptable results are withing 10% of the vendor's stipulated value.

All B.O.D. bottles are washed with a soap solution, triple rinsed with water, rinsed with distilled water and allow to air dry before using again.

HYDROLOGIC, INC.

Analytical Procedure

Title: Chloride Determination - Titrametric	
Date issued: 9 Sept 1994	Supersedes: 28 Jan. 1993
Issued by:	

Safety:

Safety glasses
Lab coat

Preservation:

Sample are to be chilled to 4°C at the time of collection. The samples must be analyzed within 28 days of collection

Reporting limits:

0.50 mg/L Cl^-

Equipment:

Buret 50 ml
Beakers (various sizes)
Erlyenmeyer flask 150 ml
Stir bars
Stir plate
Volumetric flask (various sizes)

Reagents:

Nitric acid (3+997) *Preparation:* To a 1000 ml volumetric flask pipet 3.0 ml of concentrated nitric acid (HNO_3). Dilute to volume with deionized water. Shake to mix.
Mercuric nitrate 0.0141 N Purchased from a reputable chemical supllier. Do not use if the expiration date has been exceeded.
Mixed indicator (Diphenylcarbazone-borophenol blue) Purchased from a reputable chemical supllier. Do not use if the expiration date has been exceeded.
Acidifier Reagent: Purchased from a reputable chemical supllier. Do not use if the expiration date has been exceeded.
10% NaOH *Preparation:* Weigh to the nearest 0.1 g, 10 g of NaOH pellets. Add 90 ml of deionized water. By means of a stir rod agitate to dissolve. This heat of solution is slightly exothermic, use caution to avoid burns.
0.025 N Sodium chloride (NaCl) *Preparation:* Weigh to the nearest 0.2 mg , 1.4613 g of NaCl which has been previously dried for 3 hours at 110°C. Quantitatively transfer to a 1L volumetric flask. Add enough water to dissolve. Dilute to volume with deionized water. Shake to mix.
Performance standard of known concentration.

Procedure:

Standardization:

Transfer 10.0 ml of 0.025N NaCl to a 150 ml Erlenmeyer flask. Record the volume on the benchsheet. Add water to bring total volume in the flask to 50 ml. Add a stir bar

Add 10 drops of mixed indicator and 3 drops of acidification reagent. With agitation add 10% NaOH until the solution is blue violet (a red violet color indicates a slight excess of NaOH and has no affect on the analysis.) Add 3+997 HNO_3 dropwise until the solution is yellow. Add a 1 ml excess of 3+997 HNO_3

Titrate with 0.0141 N $Hg(NO_3)_2$ to the blue-violet endpoint. Record the volume of $Hg(NO_3)_2$ required on the benchsheet.

Calculate the normality of the titrant (see calculations section) and record the normality on the benchsheet.

Sample determination:

Transfer 100 ml of sample or an aliquote of sample diluted to 100 ml to a 150 ml Erlenmeyer flasks. Record the sample volume on the benchsheet.

Add 10 drops of mixed indicator and 3 drops of acidifier reagent. If a blue-violet color develops add 3+997 HNO_3 dropwise with agitation until the solution is yellow. If the color of the solution is initially yellow proceed to the next step.

Then add 10% NaOH dropwise until the solution become blue-violet (red violet color indicates a slight excess of NaOH; this has no affect on the analysis.) Back titrate to a yellow color using 3+997 HNO_3. Add a 1 ml excess of HNO_3.

Titrate with standard $Hg(NO_3)_2$ to the blue-violet endpoint. Record the titre required on the benchsheet.

Calculate the chloride concentration in the sample and record on the benchsheet. The chloride is in mg/L Cl^-

A blank should be run and subtracted from the ml $Hg(NO_3)_2$ required to titrate both the samples and the standardization. Record the blank value (ml $Hg(NO_3)_2$) on the benchsheet.

Calculation:

Standardization:

$$N\ Hg(NO_3)_2 = \frac{ml\ 0.025\ N\ NaCl \times 0.025}{(ml\ Hg(NO_3)_2 - ml\ blank)}$$

Sample determination:

$$mg/L\ Cl^- = \frac{(ml\ of\ Hg(NO_3)_2 - blank) \times N\ Hg(NO_3)_2 \times 35450}{Sample\ volume\ (ml)}$$

Relative percent difference:

$$RPD = \frac{|Repl.\ 1 - Repl.\ 2)|}{((Repl.\ 1 + Repl.\ 2)/2)} \times 100$$

Spike Recovery:

$$\%\ Spike\ Recovery = \frac{mg\ Cl^-\ spiked\ sample - mg\ Cl^-\ unspiked\ sample}{mg\ Cl^-\ spiked} \times 100$$

Standard Recovery

$$\%\ Recovery = \frac{Found\ value}{True\ value} \times 100$$

Quality Control:

Proper sample preservation is verified at log in.
The mercuric nitrate is standardized with each analytical session.
A blank is determined with each analytical session and subtracted from the standardization and sample calculation.
Duplicate analysis are performed at a minimum rate of 10%. The replicate determinations must agree within the control limits established by the Precision Control Chart. Failure to meet these acceptance criteria requires the samples to be rerun. If a second failure occurs notification of the supervisor for assistance in locating and correction of the problem is required.
A performance standard of known concentration is analyzed with each analytical session. The value found should be within the control limits established by the Reference Standard Control Chart.. If not, contact the supervisor for assistance in identification and alleviation of the problem.
Samples must be spike at a minimum rate of 10%. Spike recovery should be within the control limits established by the Accuracy Control Chart. Failure to meet these acceptance criteria necessitates rerunning the samples. A second failure requires that the supervisor be notified to assist in problem identification and correction.
Solution preparation and standardizations are documented in the benchsheet notebook.

References:

USEPA, *Methods for Chemical Analysis of Water and Wastes,* "Method 325.3 Chloride Titrimetric, Mercuric Nitrate," 1983.
USEPA, *Test Method for Evaluating Solid Waste, Physical/Chemical Methods,* SW 846 3rd Ed., " Method 9252 Chloride Titrimetric, Mercuric Nitrate," 1986.
Clesceri, Lenore S., et.. al., Eds., *Standard Methods for the Examination of Water and Wastewater 17th Ed.*, "4500-Cl- C. Mercuric Nitrate Method," p 4-69 ff, 1989.

HYDROLOGIC, INC.

Analytical Procedure

Title: Determination of Cyanide in Solids and Oils	
Date Issued: ~~12 Sep 94~~	Supersedes:
Issued by:	

Safety:

Lab Coat
Safety glasses
Latex gloves
Other measures as determined by the nature of the sample

Sample Preservation:

Sample should be chilled to 4°C at the time of collection. Refer to "Cyanide Determination" procedure for additional guidance.

Report limits:

As described in "Cyanide Determination" procedure.

Equipment:

TCLP tumbler with extraction vessels (HPDE)
Buchner funnel
Glass wool
Water driven aspirator
Separatory funnel (500 ml)

Reagents:

50% NaOH May be purchased from a reputable supplier. *Alternatively, prepare by* mixing equal weight of NaOH pellets and water. Exercise extreme care, the heat of solution is markedly exothermic and sever chemical and/or thermal burns may result. Store in a sealed plastic container labeled as to contents, date of preparation, preparer, and corrosive hazardous nature of contents.
n Hexane (C_6H_{14}): May be purchased from a reputable supplier.

Procedure:

In the presence of a free aqueous phase prepared the Buchner funnel for filtering the sample. First, prepare a 1 cm pad of glass wool cut to fit the funnel. Weigh the pad and record the weight on benchsheet. Place the glass wool filter into the Buchner funnel and wet, under aspiration, the pad with a known amount of water. Turn off the aspiration source and let all the vacuum to dissipate. Decant the liquid portion of the sample in small aliquotes into the Buchner funnel. Then transfer the solid/oily phase to the funnel and rinse the container with known aliquotes of water. When no more

liquid remains in the container, begin aspiration. A small amount of sediment passing into the filtration flask will not affect the analysis. Measure the volume of liquid collected during filtration. Determine the aqueous volume originally present in the sample by subtracting the wash volumes from the total volume obtained.

Should the washings contain an oil layer, this should first be separated from the washings using a separatory funnel. Do not include the volume of the oil in the foregoing calculation.

Transfer the solid/oily phase contained on the glass wool filter pad to a tared weighing dish. Add any oil fraction that may have been contained in the aqueous washings. Calculate the weight of the solid/oily phase by subtracting the tare of the weighing dish and filter pad from the total.

Place 25g of solid/oily phase in the extraction vessel. If the weight of the solid is >25g use a representative aliquote of sample equal to 25g. If the weight of the solid/oily phase is < 25g use all the solids and note the weight on the benchsheet.

In the event that upon mixing a sample suspected of requiring this extraction exhibits uniform suspension of solids, the sample may be analyzed directly by the steps outlined in the "Cyanide Determination" procedure.

Should the sample contain no aqueous or oily phase the procedure commences at this point.

Add to the extraction bottle the weighed solid/oily sample, 500 ml of water, and 5 ml of 50% NaOH. If a heavy grease is present add 50 ml of n hexane.

Shake the extraction bottle for 1 minute. If the pH is < 10 add an additional 5 ml of 50% NaOH. Repeat this procedure until the pH remains 10.

Tumble the mixture for 16 hours.

After 16 hours tumbling, prepare a Buchner funnel as previously described and filter the extract. Entrainment of some sediment will not effect the analysis. It is not necessary to filter all the extract, only a sufficient amount to recombine with the aqueous fraction is necessary. However, the recombination must represent the make-up of the original sample. If the sample contained no aqueous phases filter a sufficient volume to proceed with the analysis as given in the "Cyanide Determination" procedure. Should an oily layer be present after extraction, separate it by means of a separatory funnel. Again, exacting volumes are not necessary. Only sufficient volume to recombine in a representative fashion is required.

Proceed with the analysis as given in the "Cyanide Determination" procedure.

Quality Control: Those quality control parameters defined in the "Cyanide Determination" procedure apply.

References:

USEPA, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, SW 846 3rd Ed.*, " Method 9013 Cyanide Extraction Procedure for Solids and Oils," 1986.

HYDROLOGIC, INC.

Analytical Procedure

Title: Cyanide Determination	
Date issued: 11 Sep 1994	Supersedes: 15 Jan 1993
Issued by:	

Safety:

Safety glasses
Lab coat
Sample distillation and color development should be carried out under a hood.

Sample Preservation:

In the presence of oxidizing agents such as residual chlorine cyanide is destroyed. To test for the presence of oxidizing agents place a drop of sample on acidified potassium iodide-starch test paper. A blue color is a positive test. Thus, add ascorbic acid a few crystals at a time until no color is produced when a drop of sample is put on the KI-starch test paper. Add an additional 0.6 g of ascorbic acid per liter of sample.
Samples must be preserved to pH > 12 by the addition of 10N NaOH at the time of collection.
Sample should be chilled to 4°C at the time of collection
Sample must be analyzed within 14 days of collection.

Reporting limits:

0.005 mg/L CN^-

Equipment:

1000 ml Round bottom flask two neck
Condenser (Cold finger)
Absorption tube with frit
Inlet tube
Vacuum source
Water source
Spectrophotometer
250 ml Volumetric flask
100 ml Volumetric flask
Graduated cylinders (various sizes)
Pipets (various sizes)
Buret 50 ml
Stir plate and coated stir bars

Reagents:

1.25 N NaOH *Preparation:* Weigh to the nearest 0.1g, 50g of NaOH pellets. Transfer to a 1L volumetric flask and slowly dilute to volume. Heat will be generated in this process, use caution to avoid burns. Also allow solution to cool to room temperature before completing the dilution process.

0.025N NaOH: *Prepare by* weighing to the nearest 0.1 g, 10g of NaOH pellets. Transfer to a 1000 ml volummetric and dilute to volume. Heat will be generated in this process, use caution to avoid burns. Also allow solution to cool to room temperature before completing the dilution process.

Magnesium chloride solution Purchased from a reputable supplier. Do not use if expiration date has been exceeded.

Sulfamic acid Purchased from a reputable supplier. Do not use if expiration date has been exceeded.

Cyanide Standard (1000 mg/L CN^-) Purchased from a reputable supplier. Do not use if expiration date has been exceeded. This solution should be standardized on a regular basis. *Standardize by* pipetting 25 ml of standard CN^- solution into a 125 ml Erlenmeyer flask. Add 50 ml of water. Add 12 drop of Rhodamine indicator. With agitation titrate with 0.0192 N $AgNO_3$. The end point is the color change from canary yellow to salmon (reddish brown). Titrate a blank. Record data on the benchsheet. Calculate the CN- concentration (See Calculation section) This titration should be performed on a weekly basis to insure accuracy of the standards.

Pyridine Purchased from a reputable supplier. Do not use if expiration date has been exceeded.

Barbituric Acid Purchased from a reputable supplier. Do not use if expiration date has been exceeded

Sodium dihydrogen phosphate ($NaH_2PO_4H_20$) Purchased from a reputable supplier. Do not use if expiration date has been exceeded

Chloramine T Purchased from a reputable supplier. Do not use if expiration date has been exceeded

Concentrated Hydrochloric acid (HCl) Purchased from a reputable supplier.

Concentrated Sulfuric acid (H_2SO_4) Purchased from a reputable supplier.

Cyanide standards *Preparation:* Prepare a series of standards containing approximately 0.5*u*g, 1.0*u*g, 2.0 *u*g, 5.0*u*g, 10.0*u*g cyanide by serial dilution of the 1000 ppm cyanide stock solution. These concentrations should be adjusted to accommodate the

cyanide concentration found by the standardization procedure given above. (See calculation Section)

Pyridine-Barbituric Acid Reagent (Color developing reagent)
Preparation: Weight to the nearest 0.1g, 30g of barbituric acid into a 500 ml volumetric flask. Add just enough water to wash down the sides and wet the barbituric acid. Add 150 ml of pyridine and swirl to mix the flask contents. Slowly add 30 ml of concentrated hydrochloric acid, swirl to mix flask contents and let cool to room temperature. Gradually, add water to dilute to volume. Swirl between each water addition to insure mixing. Note preparation of this reagent should be done under a fume hood. When HCl is added to the pyridine copious noxious vapors will be released. This solution should be stored in the dark at approximately 4°C.

Chloramine T solution *Preparation:* To a 100 ml volumetric flask add 1.0g of Chloramine T and dilute to volume with water. This solution must be prepared fresh for each analytical session.

Sodium dihydrogen phosphate *Preparation:* In a 1000 ml volumetric flask weigh 138g of sodium dihydrogen phosphate ($NaH_2PO_4H_20$). Dilute to volume with water and store at 4°C.

Procedure:

Transfer 500 ml of sample, or an aliquote of sample diluted to 500 ml, to a 1000 ml two neck round bottom flask. Record the sample volume on the benchsheet. Add approximately 10 boiling stones and 2g of sulfamic acid.

To the absorber tube add 50 ml of 1.25 N NaOH.

Assemble apparatus and attach to vacuum source. Turn on vacuum such that the air intake through the inlet tube produces one to two bubbles per second. Turn on water to condenser.

Through the inlet tube add 25 ml of concentrated sulfuric acid in two 10 ml aliquotes and one 5 ml aliquote. Allow time in between each addition to insure complete mixing. Exercise caution to avoid regurgitation of the sulfuric acid out through the inlet tube.

Rinse the inlet tube. After a minimum of three minutes mixing add 20 ml of $MgCl_2$ solution. Again, exercise care to avoid regurgitation of the flask contents through the inlet tube. Allow flask contents to mix a minimum of three minutes.

Apply heat via the heating mantle and reflux for one hour. Once the solution begins to boil the rheostat setting may be lowered to maintain boiling.

After one hour discontinue heating and allow the solution to cool for a minimum of 15 minutes.

When cooled disassemble the apparatus and quantitatively transfer the contents of the absorber tube to a 250 ml volumetric flask. Dilute to volume with water and mix.

Standard Curve:

Prepare a standard curve by performing the previously described serial dilution of the cyanide standard. The cyanide standards should be prepared in a 100 ml volumetric flask. To each standard add enough 0.025 N NaOH to bring the volume to approximately 50 ml. Add 15 ml of NaH_2PO_4 solution to each flask and mix, then add 2 ml of Chloramine T solution and mix, wait 2 min and 5 ml of pyridine-barbituric acid solution. Dilute to volume with distilled water and mix. Allow color to develop for 8 minutes. Determine absorbance of each solution at 578 nm. The absorbance value must be determined within 15 minutes. Develop a standard curve plotting CN^- concentration in
ug against absorbance
Place curve in the benchsheet notebook

Sample Determination:

Pipet 50 ml of sample from the 250 ml volumetric flask to a 100 ml volumetric flask. To each sample add 15 ml of NaH_2PO_4 solution, 2 ml of Chloramine T solution, and 5 ml of pyridine-barbituric acid solution. Dilute to volume and mix. After 8 minutes determine the absorbance of each solution a 578 nm. Record the absorbance on the benchsheet. The absorbance must be determined within 15 minutes.

Determine the CN^- content of each sample in ug by comparing the absorbance of the samples to the standard curve. Record the value on the benchsheet.

Should the absorbance of the sample exceed the absorbance value of the highest standard and appropriately smaller aliquote should be removed from the 250 ml volumetric flask. Dilute the smaller aliquote to 50 ml using 0.25 N NaOH (10g of NaOH to 1L). Then repeat the color developing procedure.

Calculation:

Determination of CN^-:

$$\frac{\text{ug of } CN^- \text{ found} \times 250}{\text{Aliquote used} \times 500} = ug/ml\ CN^-$$

CN^- Standardization:

$$\frac{\text{(ml titer - blank)}}{25.0} = \text{ug/ml CN}$$

CN- calibration standards Adjustment:

$$\frac{\text{(ug/ml CN- from standardization)(aliquote ml)}}{\text{final volume (ml)}} = \text{ug/ml } CN^-$$

Standard recovery:

$$100 \text{ X } \frac{\text{Found value}}{\text{True value}} = \text{\% Recovery}$$

Relative percent difference:

$$100 \text{ X } \frac{|\text{(Repl. 1- Repl. 2)}|}{\text{((Repl. 1 + Repl. 2)/2)}} = \text{RPD}$$

Spike recovery:

$$\frac{\text{ug CN-(spiked sample) - ug CN-(unspiked sample)}}{\text{ug CN- in spike}} \text{ x } 100 = \text{\% Recovery}$$

Quality Control:

Proper sample preservation is verified at log in.
Duplicates are run at a rate of not less than 10%. The duplicate must agree within the control limits established by the Precision Control Chart. Failure to meet this criteria requires that the sample be rerun. A second failure requires notification of the supervisor for assistance in locating and correcting the problem.
For each analytical session the absorbance of the 0.5 ug (LDL-lower detection limit) , 2.0 ug, (LCS-liniearity check standard) and 10.0 ug CN^- (Hi standard)standards are determined and compared against the standard curve. Recovery of each standard must be within the control limits established for each respective standard.

Failure to recovery within these acceptance limits indicates that a new curve should be prepared.

An independent standard of known CN^- is run with each analytical session. The recovery of this standard compared against its known value must be within the control limits establish by the Reference Standard Control Chart. Failure to meet the acceptance criteria requires that the standard be rerun prior to reporting any data. A second failure requires notification of the supervisor for assistance in locating and correcting the problem.

Standard curves are prepared by each analyst at least once per quarter. Should the values of a new standard curve exceed those expected when compared against the previous curve the supervisor should be consulted prior to using the curve. The standard curve is archived in the benchsheet notebook. Each standard curve should conspicuously show the analyst name, date of preparation, instrument used, and wavelength.

Sample date and distillation date are documented on the benchsheet to validate analysis within holding time.

Document solution and standards preparation on the appropriate forms in the benchsheet notebook.

References:

Clesceri, Lenore S., *et. al.*, Eds, *Standard Methods for the Examination of Water and Wastewater, 17th Ed.*, "4500-CN E. Colorimetric Method," p 4-31 ff., 1989.

USEPA, *Methods for Chemical Analysis of Water and Wastes,* "Method 335.2, Cyanide, Total, Titrametric, Spectrophotometric," 1983.

USEPA, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW 846, 3rd Ed.*, " Method 9010 Total and Amenable Cyanide (Colorimetric, Manual)," 1986.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Digestion-Total Metals in aqueous matricies**	
Date issued: 3 August 1993	Supercedes: 13 Jan 1993
Issued by:	

Safety:

Lab Coat
Safety Glasses
Gloves
All evaporation and refluxing process must be carried out in a fume hood

Equipment:

Volumetric pipet (various sizes)
Beakers 250 ml
Volumetric flasks 100 ml
Funnels 60°
Filter paper #41 Whatman (or equivalent)
Stir rods
Watch glasses
Hot plates

Reagents:

Nanopure water or equivalent
Concentrated Nitric Acid (HNO_3)
Spiking solution

Procedure:

This procedure is applicable for all metals digestions for total metal determination except arsenic (As), selenium (Se), and mercury (Hg).
By means of a 100 ml volumetric pipet transfer 100.0 ml of sample to a 250 ml beaker.
Add 3.0 ml of concentrated HNO_3. Place a stir rod in the beaker and mix the contents.
Under a hood, heat the samples to evaporate volume to approximately 25 ml. The temperature must not exceed 95°C. Using the stir rod, stir the solution occasionally.
When the sample volume has been reduced remove from the hot plate and allow to cool to room temperature.
Add 2 ml of deionized water and an additional 3.0 ml of concentrated HNO_3. Return the beaker to a hot plate and cover with a watch glass.
Reflux the sample for 1 hour with gentle heat. Do not let the temperature exceed 95°C.
At the end of 1 hour remove the sample from the hot plate and cool.
When cool add an additional 3.0 ml of HNO_3 and reflux another hour.

Continue this process until the digestion is complete as evidenced by the absence of red NO_x fumes.
When the digestion is complete remove the sample from the hot plate and let cool to room temperature.
Quantitatively filter the sample through Whatman #41 filter paper into a 100 ml volumetric flask. Dilute to volume with deionized water.

Quality control:

Samples should be preserved to pH<2 with HNO_3 and chilled to 4°C at the time of collection. Sample should be analyzed within 6 months of collection.
Duplicate analysis are performed at a rate of not less than 10%.
Spike samples are run at a rate of not less than 10%. Spike are prepared by taking a second 100 ml aliquote of the selected sample and adding an aliquote of spike solution containing the anlyte(s) of interest. The sample is carried through the digestion procedure.
Weekly digestion blanks are run to verify cleanliness of glassware and purity of reagents. A blank is a 100 ml aliquote of nanopure water carried through the digestion procedure.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Digestion-Total Metals in aqueous matrices for ICP Determination**	
Date issued: 3 August 1993	Supercedes:
Issued by:	

Safety:
Lab Coat
Safety Glasses
Gloves
All evaporation and refluxing process must be carried out in a fume hood

Equipment:
Volumetric pipet (various sizes)
Beakers 250 ml Griffin
Volumetric flasks 100 ml
Funnels 60°
Filter paper #40 Whatman (or equivalent)
Stir rods
Watch glasses
Hot plates

Reagents:
Nanopure water or equivalent
Concentrated Nitric Acid (HNO_3)
Concentrated Hydrochloric Acid (HCl)
Spiking solution

Procedure:
This procedure is applicable for all aqueous metals digestions for total metals determination except mercury (Hg).
By means of a 100 ml volumetric pipet transfer 100.0 ml of sample to a 250 ml beaker.
Add 3.0 ml of concentrated HNO_3. Place a stir rod in the beaker and mix the contents.
Under a hood, heat the samples reducing the sample to a small volume. Do not allow the beaker to go dry. The temperature must not exceed 95°C. Do not allow the contents to boil. Using the stir rod, stir the solution occasionally.
When the sample volume has been reduced remove from the hot plate and allow to cool to room temperature.
Add additional 3.0 ml of concentrated HNO_3. Return the beaker to a hot plate and cover with a watch glass. Reflux the sample for 1 hour with gentle heat. Do not let the temperature exceed 95°C.

At the end of 1 hour remove the sample from the hot plate and cool.
When cool add an additional 3.0 ml of HNO_3 and reflux another hour.
Continue this process until the digestion is complete as evidenced by the absence of red NO_x fumes or that the solution does not change color with subsequent additions of HNO_3.
Again evaporate to a low volume avoiding boiling or allowing the beaker to go dry.
Cool the beaker and contents.
Add 10 ml of 1+1 HCl. Recover the beaker with a watch glass and reflux for an additional 15 minutes to dissolve any precipitate or residue resulting from the evaporation steps.
Cool the beaker and contents. In the presence of undissolved silicates or solids which might clog the nebulizer quantitatively filter the sample through Whatman #40 filter paper into a 100 ml volumetric flask. Dilute to volume with deionized water. The final acid concentration is 10%.

Quality control:

Samples should be preserved to pH<2 with HNO_3 and chilled to 4°C at the time of collection. Sample should be analyzed within 6 months of collection.
Duplicate analysis are performed at a rate of not less than 10%.
Spike samples are run at a rate of not less than 10%. Spike are prepared by taking a second 100 ml aliquote of the selected sample and adding an aliquote of spike solution containing the anlyte(s) of interest. The sample is carried through the digestion procedure.
Digestion blanks are run with each digestion batch to verify cleanliness of glassware and purity of reagents. A blank is a 100 ml aliquote of nanopure water carried through the digestion procedure.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Total Metals Digestion for Sludges, Sediments, and Soils**	
Date issued: 4 July 1994	Supercedes: 5 August 1993
Issued by:	

Safety:

Lab Coat
Safety glasses
Gloves
All digestion steps must be carried out under a fume hood

Equipment:

Analytical balance capable of weighing to 0.01g
Beakers 250 ml
Thermometer -15°C to 200°C
Watch glass
Glass stir rods
Filter paper Whatman #40
Volumetric flask 100 ml
Funnel 60°
Hot plates
Volumetric pipets various sizes
Drying oven capable of maintaining 104° ± 2°C

Reagents:

Concentrated Nitric acid (HNO_3)
Concentrated Hydrochloric acid (HCl)
Hydrogen peroxide 30%
Nanopure water
1+1 Nitric acid *Prepare by:* Mixing equal portions of concentrated HNO_3 and water. Care should be exercised to add the HNO_3 to the water. The heat of solution is extremely exothermic, due care should be exerted to avoid burns.

Procedure:

Sample Digestion:
Thoroughly mix the sample to insure homogeneity.
Into a 250 ml beaker weigh, to the nearest 0.01g, 1.0 to 2.0g of sample. In the event that the sample is low in solids, larger sample sizes may be used. When in doubt contact the supervisor. Record the sample weight on the appropriate benchsheet.
To each sample add 10 ml of 1+1 HNO_3. By means of a glass stir rod, mix the sample and acid solution. Use care, often heat is generated and basic soils will tend to effervesce.

Cover with a watch glass, place on the hot plate, heat the mixture to 95°C and reflux for 10 to 15 minutes.
At the end of 15 minutes let the mixture cool.
Add 5 ml of concentrated HNO_3, recover, and reflux for an additional 30 minutes.
Repeat this step with an additional 5 ml of HNO_3 added after the mixture is cooled.
At the end of the second reflux period, reduce the volume in the beaker to 5 ml. Do not allow the any portion of the bottom of the beaker to go dry. Also do not allow the solution to boil. Should either of these event occur, discard the sample and begin again.
When the solution has reached approximately 5 ml remove from the hot plate and allow it to cool.
Add 2 ml of nanopure water and 3 ml of 30% H_2O_2.
Recover the beaker and return it to the hot plate. Cautiously warm the beaker and its contents. Exercise care as the effervescence associated with the peroxide reaction proceeds to avoid sample loss or injury. Continue warming until effervescence subsides.
Cool the beaker. Add an addition 1 ml of 30% H_2O_2 and repeat warming. Continue adding 1 ml aliquotes of 30% H_2O_2 to cooled samples followed by rewarming until the effervescence is minimal or the sample generally does not change in appearance. In no case add more than 10 ml total of 30% H_2O_2 to the sample mixture.
If the metals are to be determined by FLAA or ICP, add 5 ml of concentrated HCl and 10 ml of nanopure water.
Cover the beaker, return it to the hot plate, and reflux for 15 minutes.
At the end of the final reflux, cool the beaker, and quantitatively transfer the sample to a 100 ml volumetric flask. At the end of the digestion process, should the sample contain undissolved solids which will clog the nebulizer, the quantitative transfer should be accomplished by filtering the sample quantitatively through Whatman #40 filter paper. Dilute the sample to volume with nanopure water. Record the final volume on the benchsheet.
If the metals are to be determined by GFAA continue to heat the solution resulting from the addition of H_2O_2 reducing the volume to 5 ml.
Remove the solution from the hot plate and allow it to cool.
Quantitatively transfer the sample solution to a 100 ml volumetric flask and dilute to volume with nanopure water. Should the digestate contain solids which will interfere with proper instrument operation, the quantitative transfer should be accomplished by

Cover with a watch glass, place on the hot plate, heat the mixture to 95°C and reflux for 10 to 15 minutes.

Percent Solids Determination:

After beginning the digestion process, weigh to the nearest 0.1 g a minimum 5 g aliquote. Record as initial weight on page 2 of benchsheet.

Place in the drying oven at 104°C for 3 hours.

At the end of the 3 hours reweigh the sample and record as final weight on page 2 of the benchsheet.

Calculate % solids as given in the calculation section.

Calculation:

$$\% \text{ Solids} = \frac{\text{Final weight (b)}}{\text{Initial weight (a)}} \times 100$$

Quality Control:

Samples should be collected in approved properly cleaned containers and chilled as practicable.

Samples should be analyzed as soon after collection as possible.

For each digestion batch samples should be run in duplicate at a rate of not less than 10%. Percent solids should also be determined in duplicate at a rate of not less than 10%.

For each digestion batch randomly chosen samples should be spiked by adding a known volume of spike solution to a replicate sample and carrying the sample plus the spike through the digestion process. Spikes should be performed at a rate of not less than 10%.

Reference samples, as available, should be carried through the digestion process.

All weights and volumes should be recorded on the appropriate benchsheet.

References:

"Test Methods for Evaluating Physical and Chemical Methods, SW-846," 3rd Ed.

Memorandum from North Carolina Department of Envrionme Health, and Natural Recouces, June 20, 1994.

HYDROLOGIC, INC.

Analytical Procedure

Title: Metals Digestion-Total Recoverable/Dissolved with ICP Determination	
Date Issued: 4 August 1993	Supercedes:
Issued by:	

Safety:

Lab coats
Safety glasses
Gloves
All digestion steps should be carried out under a fume hood

Equipment:

Volumetric pipets (Various sizes)
Beakers 250 ml Griffin
Volumetric flasks 100 ml
Funnels 60°
Glass stir rods
Whatman #40 filter paper or equivalent
Hot Plates

Reagents:

Nanopure water or equivalent
Concentrated nitric acid (HNO_3)
Concentrated hydrochloric acid (HCl)
Spiking solution

Procedure:

Total recoverable metals should be acidified at the time of collection by adding HNO_3 at the rate of 5 ml/L.
Dissolved metals should, at the time of collection, first be filter through a 0.45 μm filter and then acidified with HNO_3 at the rate of 5 ml/L.
Transfer a well mixed 100 ml aliquote of sample into a 250 ml beaker.
Add 2 ml of HNO_3 and 5 ml of HCl. Mix with glass stir rod.
Place samples on a hot plate and reduce the volume to 15-20 ml. The solution temperature should remain between 90°C and 95°C. In no case should the solution be allowed to boil. Should the solution boil, discard the sample and begin again.
After the volume has been reduced, let the beaker and solution cool to room temperature. Wash the wall of the beaker into the sample solution. If particulates which might clog the nebulizer are present quantitatively filter into a 100 ml volumetric flask through Whatman #40 filter paper. Dilute to volume with nanopure water.

Should filtration not be necessary, quantitatively transfer the sample to a 100 ml volumetric flask and dilute to volume with nanopure water.
The sample is now ready for analysis by ICP.

Quality Control:

Total recoverable metal should be preserved by adding HNO_3 at the time of collection at a rate of 5 ml/L and chilled to 4°C.
Dissolved metals should be, at the time of collection, filtered through a 0.45 μm filter, then preserved with HNO_3 at the rate of 5 ml/L and chilled to 4°C.
Both total recoverable metals and dissolved metals should be analyzed within 6 months of collection with the exception of mercury. Mercury must be analyzed within 28 days of collection.
Duplicate samples are run at a rate of not less than 10%
Sample spikes are prepared by taking a second 100 ml of a randomly selected sample and adding a known amount of spike solution. Samples should be spiked at a rate of not less than 10%.
A reagent blank is prepared with each digestion blank by using a 100 ml aliquote of nanopure water and carry it through the digestion procedure.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Digestion-Total Arsenic and Selenium in aqueous matrices**	
Date issued: 3 August 1993	Supercedes:
Issued by:	

Safety:

Lab coat
Safety glasses
Gloves
All evaporation and refluxing must be carried out in a fume hood

Equipment:

Volumetric pipet (Various sizes)
Beakers 250 ml Griffin
Funnels 60°
Filter paper Whatman #41 of equivalent
Glass stir rods
Watch glasses
Hot plates

Reagents:

Nanopure water or equivalent
Concentrated Nitric Acid (NHO_3)
Hydrogen peroxide H_2O_2 (30%)
Spiking solution

Procedure:

This procedure is applicable determination of aqueous total arsenic (As) and total selenium (Se) by graphite furnace AA.
By means of a 100 ml volumetric pipet transfer 100 ml of well mixed sample to a 250 ml beaker.
Add 2 ml of 30% H_2O_2 to the sample. By means of a glass stir rod mix the H_2O_2 and the sample.
Add 1 ml of concentrated nitric acid.
Gently heat the solution to no greater than 95°C. If the temperature at any time exceeds 95°C or the samples goes to dryness discard the sample and begin the analysis again.
Continue heating until the digestion is complete or the volume is reduced to slightly less than 50 ml.
Discontinue heating and allow the solution to cool.
In the presence of undissolved solids, filter the sample quantitatively through #41 Whatman filter paper into a 100 ml volumetric flask.
Dilute to volume with nanopure water and mix well.

Quality Control:

Sample should be preserved to pH < 2 with nitric acid and chilled to 4°C the time of collection. The samples should be analyzed within 6 months of collection.

Duplicate samples are performed at a rate of not less than 10%.

Blanks are prepared by using 100 ml of nanopure water carried through the digestion procedure. Blanks should be prepared for each digestion batch.

Spike samples are run at a rate of not less than 10%. Spikes are prepared by taking a second 100 ml aliquote of the selected sample and adding a known aliquote of the analyte of interest. This samples is carried through the entire digestion procedure.

HYDROLOGIC, INC.

Analytical Procedure

Title: Dishwashing	
Date Issued: 29 Jan. 1993	Supercedes:
Issued by:	

Safety:

Lab Coat
Safety Glasses
Gloves

Equipment:

Brushes (various sizes)

Reagents:

Contrad 70 Detergent CMS Cat. #117-655
1+1 Nitric acid (HNO_3) *Preparation:* To 250 ml of deionized water slowly add 250 ml of concentrated nitric acid. Use caution, heat will be generated as a result of this addition.
1+1 Hydrochloric acid (HCl) *Preparation:* To 250 ml of deionized water slowly add 250 ml of concentrated hydrochloric acid. Use caution heat will be generated from this addition.

Procedure:

General
Rinse the dirty labware under a stream of running water.
Prepare a soap solution which is very approximately 2% in Contrad 70.
Submerse the dirty labware in the soap solution. For more stubborn residue the labware may require soaking in soap solution.
Scrub each piece of labware with the appropriate brush. Thoroughly, clean all surfaces both internal and external.
Rinse the labware under a stream of running tap water. Make certain all traces of soap are removed. Typically, this will take four water rinses.
Properly cleaned labware will be free of residue from previous analysis. No water droplets will form on any surface.
Return labware to the appropriate storage area.
Metals Glassware
Follow the General cleaning procedure for glassware for metals analysis.
Following the final rinse, further rinse the internal surfaces with 1+1 HCl. Then rinse three times with distilled water. Next rinse the internal glassware surfaces with 1+1 HNO_3. Finally, rinse three times with deionized water.

Total phosphorus/phosphate Glassware

Follow the general cleaning procedure given above.

After the final water rinse, rinse the internal surfaces with 1+1 HNO3. Follow this with a triple deionized water rinse. Then add 1+1 HCl to each piece and heat to boiling under a fume hood. Let cool to room termperature. Rinse each piece three times with deionized water.

Oil & Grease

Follow the general washing procedure outlined above. This applies to both laboratory ware and sample containers.

Rinse with clean freon. Collect spent freon in another container for disposal.

Allow to air dry.

Fecal/Total Coliform Sample Bottle

Wash according to general procedures given above.

Allow to air dry.

Add appropriate preservatives as dictated by the procedure and autoclave at 121°C and 15 psig for 20 minutes minimum.

Proper sterilization is verified by adding 10 ml of T-soy broth to a total coliform bottle and incubating for 24 hours at 35°C. If the T-soy appears turbid, improper sterilization is indicated.

Pipets

Pipets should be rinsed with deionized water after use.

Place the pipet in the pipet reservior containing a 2% Contrad 70 solution.

Let the pipets soak for a minimum of eight hours, then rinse for four hours in the pipet washer.

Further cleaning may be required depending on the determination for which the pipet will be used.

Sample Containers

Follow the general washing procedures unless otherwise specified.

Depress the "mode" key repetitively until "CONC" is displayed.
Depress the calibrate key and, when prompted enter the number of standards three (3).
When prompted by "Standard 1" pipet 50 ml of the 0.5 mg/L F- standard into a 150 ml beaker. Immerse the electrodes into the solution being agitated without a vortex. Add 5 ml of TISAB.
Allow the instrument to stabilize as indicated by an audible "beep" and the prompt "READY CAL." Enter the value of the standard and depress the "Yes" key. Depress the "2nd" key followed by the "mV" key to obtain the millivolts for the standard. Record this value on the benchsheet.
Remove the electrodes from the solution, rinse and blot dry. Avoid rubbing the tips of the electrodes.
At the "Standard 2" prompt repeat the process for the second standard that is 1.0 mg/l F^-.
Finally, at the "Standard 3" prompt repeat the procedure for the third standard, 2.0 mg/L F^-.
After entry of the last standard a "percent efficiency" value will be displayed. Record this value on the benchsheet also.

Sample distillation:

Preliminary distillation of the sample removes interferences. Additionally, samples from each matrix type are analyzed routinely and the results compared to those obtained for undistilled samples to validate results for undistilled samples. (See Quality Control Section)
To the distillation flask, add 400 ml of distilled water. Slowly add 200 ml of concentrated H_2SO_4. Exercise extreme care in this process, the heat of solution is extremely exothermic. Sever thermal and/or chemical burns can result. All steps in the distillation process must be carried out in a fume hood to minimize the risk of accident.
Ensure that the acid water solution is well mixed and homogeneous. Otherwise, when the distillation starts the flask contents may violently erupt from the flask leading to equipment destruction and possible injury in the form of chemical and/or thermal burns. As with all accidents, should this unfortunate reaction occur notify the supervisor immediately !
Add 25 to 30 glass beads to the distillation flask.
Connect the distillation apparatus making certain that the joints are secure. Begin heating, by means of a heating mantle, the acid/water mixture. Heat to exactly 180°F. To avoid overheating turn the

heating mantle off when the temperature reaches 178°C.
Collect the distillate and discard. This process removes fluoride contamination.
Allow the distillation flask to cool to 80°C. Carefully add a 300 ml sample aliquote to the acid water solution remaining in the flask. Again, heat to 180°C, turning off the mantle at 178°C to prevent overheating. Collect the distillate for analysis by ISE.
Should chloride be present at levels >5000 mg/L add silver sulfate (Ag_2SO_4) at the rate of 5 mg/mg Cl^-.
The acid water solution may be repeatedly used until contaminants become entrained in the distillate. This contamination is evidenced when poor recovery of standards is observed. Additionally, if samples containing more than 3 mg/L F^- are distilled the system is flushed by distilling 300 ml of water. Repeat this process is until the fluoride content of the distillate is minimal. Combine successive flushings with the first distillate for analysis.
After periods of inactivity the foregoing flushing procedure is repeated and the distillate discarded.

Sample determination:

Into a 150 ml beaker pipet a 50 ml homogeneous aliquote of sample. Record the volume on the benchsheet. Begin agitation such that no vortex is formed.
Pipet 5 ml of TISAB into the sample and immerse the electrodes. The instrument will automatically begin the measuring process. Allow the instrument to come to equilibrium as indicated by an audible beep and a "RDY" prompt. Record the value on the benchsheet. If the F^- value exceeds the range of the curve, >2 mg/L F^-, an aliquote less than 50 ml is pipetted into a 50 ml volumetric flask and diluted to volume. Record the sample volume on the benchsheet and repeat the sample determination steps. Continue reducing the sample aliquote until the F^- concentration falls within the range defined by the standard curve. Calculate the F^- concentration as defined in the Calculation section and record the value reported on the benchsheet.

Calculations:

Concentration (mg/L) F^-:

$$\text{mg/L } F^- = \frac{\text{mg/L } F^- \text{ observed} \times 50 \text{ ml}}{\text{Sample aliquote}}$$

Relative percent difference (RPD):

$$RPD = \frac{|(Repl.\ 1 - Repl.\ 2)|}{((Repl.\ 1 + Repl.\ 2)/2)} \times 100$$

Spike Recovery:

$$\%\ Recovery = \frac{mg/L\ F^-\ spiked - mg/L\ F^-\ unspiked}{Spike\ conc.} \times 100$$

Standard recovery:

$$\%\ Recovery = \frac{Found\ value}{True\ value} \times 100$$

Quality Control:

Proper sample preservation is verified at log in.
Sample duplicates are run at a minimum rate of 10%. The relative percent difference between the replicates are to be within the control limits established by the precision control chart of $\leq$ 20% RPD which ever is lowest. Failure to meet these acceptance criteria requires that the samples be rerun. On a second failure the supervisor is notified for assistance in identifying the problem and resolving it prior to reporting data.
A minimum of one sample per analytical session is analyzed without distillation and distilled. Agreement between the two runs is as defined in the duplication requirement above..
Samples are spiked at a minimum rate of 10%. Spike recoveries are to be within the control limits defined by the accuracy control chart or $\pm$ 15% which ever is lowest. Failure to recover within these acceptance criteria necessitates that the samples be rerun. If a second failure occurs notify the supervisor for assistance in locating and correcting the problem before reporting data.
Prior to beginning actual sample determination the standard curve is validated by running a linearity check standard (LCS) and an independent QC standard of known fluoride concentration. Acceptable recoveries for these standards are within the control

limits established by their respective control charts or ±10%, which ever is lowest. Failure to obtain these results requires that the instrument be restandardized and the standards rerun. If a second failure occurs notify the supervisor for assistance in locating the problem and correcting it prior to reporting data.

Instrument stability is demonstrated by running the LCS standard after every tenth sample or fraction thereof. Acceptance criteria are the same described for the LCS standard above. After one failure the LCS standard may be rerun. Failure to obtain acceptable results requires that the instrument be restandardized and the samples run since the last acceptable LCS check be rerun. Report the data obtained after restandardization and successful QC validation.

References:

Clesceri, Lenore S., et.al., Eds., *Standard Methods for the Examination of Water and Wastewater, 17th Ed.*, "4500-F- Fluoride," p 4-84 ff., 1989.

USEPA, *Methods for the Chemical Analysis of Water and Wastes*, "Method 340.2 Fluoride Potentiometric, Ion Selective Electrode," 1983.

USEPA, *Methods for the Chemical Analysis of Water and Wastes*, "Method 340.1 Fluoride, Total Colorimetric , SPANDS with Bellack Distillation," 1983.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Fecal Coliform Determination-Membrane Filter**	
Date issued: 13 Jan. 1993	Supercedes
Issued by:	

Safety: Lab coat and safety glasses required

Equipment:
Magnetic filter and base (Gelman or equivalent)
1000 ml filtering flask
Vacuum or aspirator
Culture dishes with absorbent pads
Presterilized membrane filters
Forceps
Alcohol
Alcohol lamp
Incubator calibrated to maintain 44.5° ± 0.2°C
Assorted pipets
Presterilized whirlpaks

Reagents:
Water (Barnstead Nanopure or equivalent)
M-FC Broth *Preparation:* Weigh into a to the nearest 0.1g, 7.4g of presterilized M-FC broth. Add 2.0 ml of rosalic acid. Add 200 ml of deionized water. Mix thoroughly and heat just to boiling.. Remove from heat source and allow to cool. Determine the pH of the media. The final pH should be 7.4 ± 0.2 standard units. Record value found.
0.2 N NaOH *Preparation:* Weigh to the nearest 0.1mg, 0.8g of NaOH pellets. Dilute to 100 ml
Rosalic Acid *Preparation*: Weigh to the nearest 0.1mg, 0.5g of Rosalic acid. Add just enough of the previously prepared 0.2N NaOH to dissolve the Rosalic acid. Quantitatively transfer the resulting solution to a 50 ml volumetric flask and dilute to volume with 0.2N NaOH.
The rosalic acid should be stored in the dark at room temperature. It has a one week shelf life.
Phosphate buffer: *Preparation:* Weigh to the nearest 0.1g, 10.2g of potassium dihydrogen phosphate (KH_2PO_4). Dissolve in 300 ml of deionized water. Autoclave the resulting solution for 15 minutes at 121°C and 15 psig. The solution should be stored between 2°C and 10°C. Discard if the solution becomes cloudy.
Magnesium chloride solution: *Preparation:* Weigh to the nearest 0.1g, 40.7g of magnesium chloride hexahydrate ($MgCl_2 \cdot 6H_2O$). Dissolve in 500 ml of deionized water. Autoclave for 15 min at 121°C and 15 psig.

Dilution water: *Preparation:* To 500 ml of deionized water add 2.5 ml of $MgCl_2$ solution by means of a presterilized pipet. Add 0.7 ml of phosphate buffer by means of a presterilized pipet. Autoclave the resulting mixture for 15 min at 121°C and 15 psig. Store the mixture in the dark until ready for use.

Procedure:

Prepare the number of culture dishes corresponding to the number of samples by adding enough of the previously prepared media to saturate the pad. (Approximately 2 ml is required) Carefully remove any excess.
Using sterile forceps place a sterile membrane filter (grid up) on the base of the Gelman filtering apparatus. Carefully assemble the apparatus.
Seat the filter with a small amount of dilution water.
Transfers by means of a presterilized pipet an aliquote of sample. Record the aliquote on the benchsheet. The aliquote volume is selected based on suspended solids content, odor, and chlorine content. The selected volume should produce between 20 and 60 colonies per filter.
Apply a gentle vacuum and aspirate sample through the filter. Rinse with three successive 20 to 30 ml aliquotes of dilution water.
Immediately after the last final rinse, disassemble the filter apparatus and transfer the filter to a previously prepared culture dish by means of sterilized forceps. While transferring the filter to the culture dish care should be exercised to avoid trapping air between the pad and the filter.
Place the culture dish with filter in a presterilized whirlpak. (Two culture dishes will fit in one whirlpak.)
Transfer the whirlpaks containing culture dishes to the wet incubator.
The whirlpaks should be oriented such that the culture plates are upside down. Incubate for 24 ± 2 hrs. at 44.5 ± 0.2°C.
At the conclusion of the incubation period remove the whirlpaks containing the culture dishes from the incubator. Count the number of fecal colonies present. Fecal coliform colonies are of various sizes and are bluish in color. Nonfecal colonies are grayish to beige in color. Use of a dissecting microscope can be employed to aid in the accuracy of the count.
Record the number of colonies found on the benchsheet.

Calculation:

$$\frac{\text{\# of fecal coliform colonies found} \times 100}{\text{sample aliquote}} = \text{Fecal coliform/ 100 ml}$$

Quality Control:

Samples must be preserved by chilling to 4°C and analyzed within 6 hours of the time of collection. Sample collection time and analysis time are documented on the benchsheet.

Duplicate analysis are performed at the rate of 10%. The average values for the duplicates are reported.

Each effluent sample is run at two different dilutions to better define fecal coliform values.

One hundred ml of dilution water is analyzed at the beginning and end or each analytical session to verify lack of cross contamination.

The wet incubator temperature is calibrated quarterly against a certified thermometer. Appropriate correction are made.

Use of presterilized bottles for sample collection is encouraged. Bottle sterility is verified by performing a coliform determination on a total coliform bottle sterilized concomitantly with the fecal bottle.

HYDROLOGIC, INC.

Analytical Procedure

Title: Fluoride Determination -ISE with Distillation	
Date issued: 8 Sep 1994	Supersedes:
Issued by:	

Safety:

Lab coat
Safety glasses
Distillation are to be carried out in a fume hood

Preservation:

Samples are chilled to 4°C at the time of collection. Samples requiring fluoride determination are to be analyzed within 28 days of collection.

Reporting limits:

0.5 mg/L F^-

Equipment:

ISE meter equipped with a fluoride electrode and appropriated reference electrode.
Stir plate and teflon coated stir bars
Teflon or HDPE beakers (sizes as required)
Pipets (sizes as required)
Volumetric flasks (sizes as required)
Bellack distillation apparatus with heating mantle.

Reagents:

Fluoride Stock Standard 1000 mg/L F^- Purchased from a reputable scientific supplier and traceable to NIST standards. Do not use stock standard that exceeds the expiration date.
Intermediate Fluoride Standard 100 mg/L: Prepare by diluting 10 ml of fluoride stock solution to 100 ml in a volumetric flask.
Total Ionic Strength Adjustment Buffer (TISAB): Purchased from a reputable scientific supplier and traceable to NIST standards. Do not use stock standard that exceeds the expiration date.
Sulfuric acid (H_2SO_4) concentrated

Procedure:

Preparation of Standard Curve:
Prepare standards that are 0.5, 1.0 and 2.0 mg/L F^- by diluting 0.5 ml, 1.0 ml, and 2.0 ml of intermediate F^- standard to 100 ml with water.
Assure that the fluoride electrode and appropriate reference electrode are installed on the ISE meter. Further, select the appropriate channel by depressing "2nd/channel" until the correct channel is displayed.

HYDROLOGIC, INC.

Analytical Procedure

Title: Total Hardness - Titrametric	
Date issued: 9 Sep. 1994	Supersedes: 30 Jan. 1993
Issued by:	

Safety:

Lab coat
Safety glasses
Preparation of buffer solution should be carried out under a hood.

Preservation:

Sample should be acidified to pH < 2 and chilled to 4°C at the time of collection. Samples for hardness must be analyzed within 6 months of collection.

Reporting limits:

1 mg/L Hardness as $CaCO_3$

Equipment:

Erlenmeyer flasks (125 ml)
Pipets (various sizes)
Stir plate with stir bars
Buret (50 ml)
Volumetric flask (250 ml)

Reagents:

Buffer solution pH 10 Purchased from a reputable chemical supplier. Do not use if expiration date has been exceeded.
EDTA titrant 0.01M Purchased from a reputable chemical supplier. Do not use if expiration date has been exceeded.
Eriochrome Black T Purchased from a reputable chemical supplier. Do not use if expiration date has been exceeded.
Calcium standard Purchased from a reputable chemical supplier. Do not use if expiration date has been exceeded.
Performance standard of known concentration

Procedure:

EDTA Standardization:
Into a 125 ml Erlenmeyer flask pipet 10.0 ml of calcium standard add sufficient deionized water to bring the volume to 50 ml.
Add 1 ml of buffer solution and 2 drops of Eriochrome Black T indicator.
With agitation titrate with EDTA. The color change will be from reddish to "Sky blue." Record titer of EDTA required on

benchsheet. Calculate the normality of EDTA (see Calculation section) and record on benchsheet.

Sample Determination:
Pipet 100 ml of sample into a 125 ml Erlenmeyer flask
Record sample volume on benchsheet.
Add 2 ml of buffer solution and 2 drops of Eriochrome Black T indicator.
With agitation titrate with standard EDTA to "Sky blue" endpoint.
Record titer of EDTA required on benchsheet.
Analyze a blank of 50 ml of deionized water as though it were a sample. Record the titer of standard EDTA required to reach the endpoint on the benchsheet.

Calculation:

EDTA Standardization:

$$N\ EDTA = \frac{0.2}{ml\ EDTA\ titer}$$

Sample Determination:

$$mg/L\ Hardness\ (as\ CaCO_3) = \frac{(ml\ EDTA) \times N\ EDTA \times 50{,}000}{Sample\ volume\ (ml)}$$

Relative percent difference:

$$RPD = \frac{|(Repl.\ 1 - Repl.\ 2)|}{((Repl.\ 1 + Repl.\ 2)/2)} \times 100$$

Standard recovery:

$$\%\ Recovery = \frac{Found\ Value}{True\ value} \times 100$$

Quality Control:

Proper sample preservation is verified at log in.
The standard EDTA titrant is standardized against a calcium standard with each analytical session.
Duplicate analysis are performed at a rate of not less than 10% The replicate samples must agree within the acceptance criteria established by the Precision Control Chart. Failure to meet this acceptance criteria requires that the samples be rerun. As second failure requires that contacting the supervisor for assistance in locating the problem and correcting it.
A performance standard is determined with each analytical session. The value must be within the control limits established by the Reference Standard Control Chart. Failure to meet this criteria requires contacting the supervisor for assistance in locating the problem and correcting it.
Standardizations and reagent preparation are documented in the benchsheet notebook.

References:

USEPA, *Methods for Chemical Analysis of Water and Wastes*, "Method 130.2 Hardness Total, (mg/l as $CaCO_3$) Titrametric, EDTA," 1983.
Clesceri, Lenore S., *et. al.*, Eds., *Standard Methods for the Examination of Water and Wastewater 17th Ed.*, "2340 c. EDTA Titrimetric Method," p 2-53 ff., 1989.

HYDROLOGIC, INC.

Analytical Procedure

Title: Hexavalent Chromium Aqueous Matrices	
Date Issued: 8 Sep 94	Supersedes:
Issued by:	

Safety:

Safety glasses
Lab coat

Preservation:

Sample should be chilled to 4°C at the time of collection. Aqueous samples must be analyzed within 48 hours of collection.

Reporting limits:

0.20 mg/l Cr^{+6}

Equipment:

Spectrophotometer
Beakers (sizes as required)
Pipet (sizes as required)
Volumetric flasks (sizes as required)

Reagents:

Stock Hexavalent chromium (Cr^{+6}) solution: *Prepare by* weighing, to the nearest 0.1 mg, 0.1414 g of primary standard potassium dichromate ($K_2Cr_2O_7$) which has been previously dried for 3 hours at 105°C. Quantitatively transfer to a 1000 ml volumetric flask. Add sufficient water to completely dissolve the $K_2Cr_2O_7$. Gently swirl flask to effect dissolution. Dilute to volume. The resulting solution is 50 ug/ml Cr^{+6}.

Working Hexavalent chromium solution: *Prepare by* pipeting 10.0 ml of stock Cr^{+6} solution into a 100 ml volumetric flask and dilute to volume. The resulting solution is 5.0 ug/ml Cr^{+6}. Prepare fresh with each analytical session.

Acetone

Diphenylcarbazide solution: *Prepare by* weighing, to the nearest 1 mg, 0.250 g of 1,5-diphenylcarbazide. Quantitatively transfer with acetone to a 50 ml volumetric flask. Add sufficient acetone to fully dissolve the solids. Swirl gently to effect dissolution. Dilute to volume with acetone. Store in a labeled amber bottle. Label as to contents, date of preparation, and preparer. Discard and prepare again if the solution becomes discolored.

Sulfuric acid solution (0.1 N): *Prepare by* diluting 2.8 ml of concentrated sulfuric acid (H_2SO_4) to 1000 ml in a volumetric flask. This solution may, alternatively, be purchased from reputable reagent suppliers.

Procedure:

Preparation of Standard Curve:

Prepare a series of standards which are 10, 15, 40, 50, and 100 ug Cr^{+6} by pipetting 2, 5, 8, 10, and 20 ml of Cr^{+6} working solution. respectively, to 100 ml. Dilute to volume with 0.1 N H_2SO_4. (Use of weak H_2SO_4 assures that the solution pH is within the range required for proper color development.)

Transfer each standard to a labeled 250 ml beaker quantitatively.

Add 2 ml of diphenylcarbazide solution to each standard. Swirl gently to assure homogeneity.

Allow the color to develop for 10 minutes and record the absorbance of each standard measured at 540 nm. Record the values on the benchsheet.

Plot the standard curve (ug Cr^{+6} v absorbance). Label the plot as to method, instrument used , wavelength, and date of preparation.

A blank is prepared by carrying 100 ml of water through the analytical process. The resulting absorbance of the blank is subtracted from the standard and sample absorbance by means of zeroing the instrument with the blank.

Sample Determination:

Transfer a homogeneous 50 ml aliquote of sample to a 100 ml volumetric flask. A smaller sample aliquote may be used if the Cr^{+6} concentration exceeds the range defined by the standard curve. Record the sample volume on the benchsheet. Dilute to volume with 0.1 N H_2SO_4. (Use of weak H_2SO_4 assures that the solution pH is within the range required for proper color development.)

Quantitatively transfer the diluted sample to a labeled 250 ml beaker. Add 2 ml of diphenylcarbazide solution and swirl gently to insure homogeneity. Let the color develop for 10 minutes.

Measure the absorbance at 540 nm of each sample and record the value on the benchsheet.

Calculate the ug of Cr^{+6} in the sample by comparing the observed absorbance to the standard curve. The ug Cr^{+6} found must be within the limits defined by the curve. Otherwise, a smaller aliquote as discussed above should be used.

Calculate the concentration of Cr^{+6} in the sample. (See calculation section)

Calculations:

ug/ml Cr^{+6}:

$$\text{ug/ml } Cr^{+6} = \frac{\text{ug } Cr^{+6} \text{ from curve}}{\text{Sample volume (ml)}}$$

Relative percent difference:

$$RPD = \frac{|(\text{Repl 1} - \text{Repl 2})|}{((\text{Repl. 1} + \text{Repl. 2})/2} \text{ X } 100$$

Standard recovery:

$$\% \text{ Recovery} = \frac{\text{Found value}}{\text{True value}} \text{ X } 100$$

Spike recovery:

$$\% \text{ Recovery} = \frac{(\text{ug } Cr^{+6} \text{ spike} - \text{ug } Cr^{+6} \text{ unspiked})}{\text{ug } Cr^{+6} \text{ in spike}} \text{ X } 100$$

Quality Control:

Proper sample preservation is verified at log in.
Standard curves are prepared on a quarterly basis and documented in the benchsheet notebook. The standard curve shall have the analyst name, instrument, wavelength, and date of preparation conspicuously displayed on the curve.
With each analytical session the lower detection limit standard (LDL), linearity check standard (LCS), and high standard shall be run. The recovery of each standard shall be compared to the true value as defined in the Calculation section. The recovery of each standard shall be within the control limits defined in respective standard control charts or $\pm$10% which ever is less. Failure to meet these criteria requires that the standard curve be prepared again..
Duplicates shall be run at a minimum rate of 10%. The relative percent difference, as calculated as defined above, between the replicates shall be within the control limits establish by the precision control chart or $\leq$20% which ever is lowest. Failure to met these criteria requires that the sample be rerun. On a second failure the

supervisor must be notified for assistance in locating and correcting the problem before reporting the results.
Samples shall be spiked at a minimum rate of 10%. Spike recovery, calculated as given in the Calculation Section, shall be within the control limits defined in the accuracy control chart or ±10% which ever is less. Failure to met these criteria requires that the sample and spike be rerun. A second failure necessitates notification of the supervisor for assistance in identification and resolution of the problem before reporting the results.
Very high amounts of molybdenum, vanadium, iron and copper can interfere in the determination of hexavalent chromium. However, when the proper wavelength is used in the determination the interferences are negligible. If it is believed that interfering amounts of these metals are present, contact the supervisor for assistance.

References:

Clesceri, Lenore S., *et al.*, Eds., *Standard Methods for the Examination of Water and Wastewater, 17th Ed.*, "3500-Cr D Colorimetric Method," p 3-91 ff, 1989.
USEPA, "*Methods for Chemical Analysis of Water and Wastes*, "Method 218.5 Chromium Hexavalent, Dissolved," 1983.
USEPA, *Test Methods, for Evaluating Solid Waste, Physical/Chemical Methods, SW 846, 3rd Ed.*,, "Method 7196A Chromium, Hexavalent (Colorimetric)," 1986.

HYDROLOGIC, INC.

Analytical Procedure

Title: Log-in	
Date issued: 6 Jan 1992	Supercedes
Issued by:	

Safety: Lab coat and safety glasses required.

Equipment: Log-in forms
Computer with Labtrol installed

Procedure: Samples arrive at the laboratory from three sources. First, operators employed by HydroLogic. Second, from clients delivering their own samples. Thirdly, from customers shipping their samples to the laboratory. This procedure applies to all samples regardless of the method by which they arrive.

Verify the samples are accompanied by a chain-of-custody. The chain should contain information regarding who collected the sample, the date/time of the sample, analysis required, and preservation techniques employed. Refer to HydroLogic's Sample Preservation Procedure for correct preservation techniques.

Upon arrival the shipment container (generally a cooler) is emptied. Verify that the samples arrived at 4oC. If the samples are in a water/ice mixture this requirement is satisfied.

Verify that the containers received are consistent with the information on the chain-of-custody.

Verify pH of those samples that require pH adjustment as a preservative.

In the case of fecal coliform analysis verify that the samples arrive at the laboratory within 4 hours of collection.

Enter the appropriate information on the proper log sheet.

Transfer samples to the appropriate holding area. Any sample which will not be analyzed within 4 hours should be placed in a refrigerator. All coliform samples should be refrigerated until the time of analysis. Those samples receiving immediate analysis should be delivered to the appropriate analytical area and the analyst notified. Those samples with a holding time of 48 hours should be transferred to the appropriate holding area and the analyst or his supervisor notified of the receipt of the sample.
Transfer log-in information to Labtrol. Print labels for each sample. Print log-in information as prompted by Labtrol and submit to Lab Supervisor along with the chain-of-custody.
Transfer labels to appropriate samples.

Quality Control: If verification are incorrect notify the Lab. Supervisor immediately. The Lab Supervisor will notify the client of protocol violations. The customer will be encouraged to resample. However, if the customer insists on running the samples the Lab. Supervisor will notify NCDEHNR of the violation as required.

HYDROLOGIC, INC

Analytical Procedure

Title: Metals Determination Flame AA	
Date issued: 20 Jan 1993	Supercedes:
Issued by:	

Safety:

Exhaust hood
Safety glasses
Lab coat

Equipment:

Atomic absorption spectrophotometer
Hallow cathode lamps/electrodeless discharge lamps
Volumetric glassware (various sizes)
Pipets (various sizes)
10 ml buret

Reagents:

Nitric acid
Nanopure water
Stock standard solution. specific to the element of interest
Performance standard of known concentration
High purity acetylene
USP nitrous oxide
Compressed air

Procedure:

Determine the element of interest and install the proper lamp
Optimize the lamp to provide maximum energy.
Clean the appropriate burner head and install.
Install appropriate aerosol device.
Select proper gas combination and light the burner.
Optimize burner head in light path to give maximum absorbance for the high standard.
Standard curve:
Set the zero by aspirating blank water.
Aspirate each standard starting with the lowest standard and progressing to the highest.
The curve is plotted by the instrument software.
Aspirate the lower detection limit standard.
Aspirate the independent performance standard.
Sample determination:
Aspirate each sample. For total metals aspirate the previously digested sample. (See Digestion-Total Metals Procedure). For

dissolved metals aspirate an aliquote of sample previously filtered through a 0.45 um filter.
Should the sample concentration exceed the highest standard value. dilute the sample so that the observed absorbance falls within the range of the curve and rerun.
Record run on Lotus 1-2-3 spreadsheet. Archive information on floppy disk. The file name should be the symbol of the element determined followed by the date of the determination. (e.g. For a copper run on 1/2/93 the file name would be CU010293.wk1)

Calculations:

No calculation is required if the sample was run without dilution. The instrument software will present the concentration found in a suitable format.
If dilution was required

$$\text{mg/l of metal} = \frac{\text{mg/l found x 100}}{\text{Aliquote used}}$$

QA/QC calculation:
Standard recoveries:

$$\text{\% Recovery} = \frac{\text{Value found x 100}}{\text{Target value}}$$

Spike recoveries:

$$\text{\% Recovery} = \frac{\text{(mg/l sample + spike) - (mg/l sample only) x 100}}{\text{mg/l of spike}}$$

Quality Control:

Samples should be preserved by the addition of HNO_3 to pH < 2 and cooled to 4°C at the time of collection.
Standard curve should be prepared with each analytical session. The curve should be drawn at the end of the run. A correlation coefficient of 0.995 or greater is required. A curve outside this limit should be rerun using freshly prepared standards. If this criterion is still outside acceptable limits contact the supervisor. The lower detection limit should agree ± 20% of the expected value. Should the value found produce a recovery >20% (see calculations section) the standard maybe rerun one time. If an

Quality control (cont.)

acceptable value is still unattained contact the supervisor.
The performance standard should agree within ± 20% of the vendor's published value. Should a value found produce a recovery of > 20% (see calculations section) the standard may be run one additional time. If an acceptable value is still unattained contact the supervisor.
Duplicates should be performed at a rate of not less than 10%.
Post digestion spikes should be performed at a rate of not less than 5%. Recovery should be within ±25%. (see calculation section)
Should more than 25 samples be determined in one analytical session run the performance evaluation as the last sample. The acceptance criteria is the same as previously described. This validates the stability of the instrument and its operating parameters.
Standards preparation date is documented on the summary spreadsheet.
Proper preservation is verified at log in.
A maintainence contract should be maintained with the instrument vendor.

HYDROLOGIC, INC.

Analytical Procedure

Title: Metals Determination Furnace AA	
Date issued: 12 April 1992	Supercedes:
Issued by:	

Safety:

Exhaust hood
Safety glasses
Lab coat

Equipment:

Atomic absorption spectrophotometer
Hallow cathode lamps/electrodeless discharge lamps
Volumetric glassware (various sizes)
Pipets (various sizes)
Graphite tubes Perkin Elmer Cat. # B012-1092
L'vov platforms Perkin Elmer Cat. # B012-1091

Reagents:

Nitric acid High Purity Standard Cat # SBHNO$_3$-500
Nanopure water
Stock standard solution, specific to the element of interest (Use standards purchased from High Purity Standards when available.)
Matrix modifies appropriate to the element of interest.
Performance standard of known concentration
Argon 99.998%

Procedure:

Determine the element of interest and install the proper lamp.
Assure that the spectrophotometer optics are properly aligned for furnace operation.
Optimize lamp position in optical path for maximum energy.
Verify that the graphite furnace and L'vov platform are properly installed. Clean furnace windows as required.
Verify that the sample pipet is properly aligned so that the sample will be dispensed entirely on the L'vov platform.
Verify that the diluent reservoir and rinse reservoir a full.
Standard curve:
Through serial dilution prepare a standard equivalent to the highest standard defined by the element linearity.
Transfer a standard blank to a 2 ml beaker and place in Position 1 on the sample tray.
Transfer an aliquote of high standard to a 2 ml beaker and place in Position 2. If more than one element will be run place the second standard in Position 3 of the sample tray.

Place the appropriate matrix modifier, if required in the sample tray.
Modify the element program indicating the location of the standards and matrix modifiers as required.
When the element program is initiated the instrument will make appropriate dilutions of the stock standards, diluent, and matrix modifiers. From these dilutions a standard curve will be prepared.
Sample determination:
Transfer 2 ml of sample to a 2 ml beaker. If total metals are to be determined, place 2 ml of previously digested samples (see Digestion-Total Metals Procedure: if the samples are NC monitoring wells the Digestion-Monitoring Wells procedure) in a sample cup. To determine dissolved metals place 2 ml of sample which has been previously filtered through a 0.45 um filter in a 2 ml sample cup. Place the sample consecutively in the sample tray beginning with the lowest numbered sample position. The performance standard of known concentration should be placed as the first sample. (Note that dilution of the performance standard is often required to produce a sample which will fall within the linear range of the element.)
Label each sample in the Element File "Id/Weight Parameter" section. Labelling should include the sample id number and a brief sample description. If the sample is diluted beyond the original 100 ml this factor should also be appropriately entered. In the case of solid matrices the sample weight should be entered in the correct place in the "Id/Weight Parameter" section.
Alter the Element file to indicate the proper location, acceptable limits and run frequency for the performance standard.
Alter the Element file to indicate the samples to be spiked and spike concentration.
Initialize the instrument. If the run is not a multiple element run initialize using the "Run all" command in the element file. If a multiple element run is to be made, save the changes to all element files involved and open the "MultiElement" window. Stipulate the element to be run in the Multielement parameter section and the samples to be determined. Initialize the instrument using the "Start/Stop Auto Run" command.
The instrument will make the run utilizing the programmed delineations including diluting out of range samples. However, the instrument will only make one attempt to dilute an out of range sample. If the attempt remains out of the linear range of the element the sample must be manually diluted and rerun.

Record the run on a Lotus 1-2-3 spreadsheet. Archive the information on floppy disk. The filename should be the symbol of the element determined followed by the date the determination was begun. (E.g. For a lead run on 1/2/93 the filename would be PB010293.wk1.)

Calculations:

Sample without dilution

$$mg/L = \frac{ug/L}{1.000}$$

Diluted samples

$$mg/L = \frac{ug/L \times \text{Dilution factor}}{1,000}$$

QA/QC calculation:

Standard recoveries:

$$\% \text{ Recovery} = \frac{\text{Value found} \times 100}{\text{Target value}}$$

Spike recoveries:

$$\% \text{ Recovery} = \frac{(ug/L \text{ sample} + ug/L \text{ spike}) - (ug/L \text{ sample}) \times 100}{ug/L \text{ of spike}}$$

Quality Control:

Samples should be preserved by the addition of HNO_3 to pH < 2 and cooled to 4°C at the time of collection.
A standard curve is prepared with each analytical session and the standard should be prepared fresh with each analytical session.
A correlation coefficient of 0.995 or greater is required. If this criterion is not met contact the supervisor.
The performance standard should be run at a rate of not less than 10%. The performance standard should agree within ±20% of the vendor's published value. Should a value found produce a recovery outside these limits (see Calculations section) contact the supervisor.
Spike should be preformed at a rate of not less than 10%.
Spike recovery should be within 80 to 120%. If recovery is outside these limits contact the supervisor. In the event that the sample is a NC drinking water sample spiking should be 100%.
Drinking water recovery should be 90 to 110%. If recoveries are outside this limit contact the supervisor.
Duplicates should be performed at a rate of not less than 10%.
Standards preparation dates should be documented on the summary spreadsheet.
Proper preservation should be verified at log-in.
A maintenance contract should be maintained with the instrument vendor.

HYDROLOGIC, INC.

Analytical Procedure

Title: Metals Digestion - Monitoring Wells	
Date issued: 25 February 1993	Supercodes:
Issued by:	

Safety:

Lab coat
Safety glasses
Fume hood

Equipment:

Pipets (various sizes)
Glass funnels
Whatman #41 filter paper
Beakers
Glass stir rods
Water bath (Hamilton Beach Automatic Roaster Oven)

Reagents:

1+ 1 Hydrochloric acid (HCl) *Preparation:* Mix equal volumes of water and concentrated hydrochloric acid. Agitate to insure complete mixing. Caution: Be certain to add the concentrated HCl to the water. Use caution to avoid chemical and thermal burns.

Procedure:

To a 250 ml beaker transfer 100 ml of well mixed sample.
Add 5 ml of 1+1HCl.
Heat the mixture by means of a steam bath for 15 minutes.
Allow to cool and quantitatively filter through Whatman #41 filter paper into a 100 ml volumetric flask. Dilute to volume with reagent water.

Quality Control:

The sample may be collected in glass or plastic. At the time of collection the sample should be preserved with nitric acid at the rate of 5 ml/ 1L of sample.
The samples should be digested within 72 hours of collection.
Duplicate samples should be run at a rate of not less than 10%.
Digestion spikes should be performed at a rate of 20% Spike recovery should conform to the established recovery for the method. In no case should the recovery be greater than 120% or less than 80%. Failure of spike recovery indicates the need to rerun the sample after cause is identified and corrected.
Proper preservation is verified at log-in.

HYDROLOGIC, INC.

Analytical Procedure

Title: Methylene Blue Active Substances (MBAS)	
Date issued: ~~29 Jan. 1993~~	Supercedes:
Issued by:	

Safety:

Lab Coat
Safety Glass
All steps prior to spectrophotometric determination should be carried out under a fume hood.

Equipment:

Volumetric flask (various sizes)
Pipet (Various sizes)
Separatory funnels
Funnels
Glass wool
Spectrophotometer with cuvets (glass)
Gelman filter apparatus, filtering flask and 0.45 um filters

Reagents:

Linear alkyl sulfonate (LAS) Ricca Cat. #4350
Chloroform
Methylene Blue Reagent Ricca Cat. #4900
Wash Solution *Preparation:* Fill a 1000 ml volumetric flask about half full with deionized water. Add 6.8 ml of concentrated sulfuric acid. Weigh to the nearest 0.1g, 50g of sodium dihydrogen phosphate monohydrate and quantitatively transfer to the 1000 ml flask. Swirl until dissolved. Dilute to volume with deionized water.

Procedure:

Standard curve:
Prepare an intermediate standard by pipeting 5.0 ml of LAS stock solution to a 500 ml volumetric flask. Dilute to volume with deionized water and shake to mix.
From the intermediate standard pipet 1, 2, 4, 6, 8, and 10 ml into separatory funnels. Add sufficient water to bring the volume to 100 ml. These standards will be 1, 2, 4, 6, 8, and 10 ug LAS respectively.
Complete the analysis as described in Sample Determination Section. Plot ug LAS against absorbance to form the standard curve.

Sample Determination:

Filter a minimum of 100 ml of sample through a 0.45 um filter.
Transfer 100 ml of sample or an aliquote of sample to a separatory funnel. If an aliquote of less than 100 ml of sample is used add sufficient water to bring the volume to 100 ml. Record sample volume on benchsheet.
Add 25 ml of methylene blue reagent and 10 ml of chloroform. Shake the separatory funnel for 30 seconds. Allow layers to separate and drain the chloroform layer into another separatory funnel.
Repeat the chloroform extraction three additional times using 10 ml of chloroform each time. Combine each extraction in the second separatory funnel.
To the second separatory funnel add 50 ml of wash solution. Shake for thirty seconds. Drain the chloroform through glass wool into a 100 ml volumetric flask.
Repeat the chloroform extraction twice more with 10 ml portions of chloroform. After each 10 ml addition shake the separatory funnel, allow the layers to separate, and drain the chloroform layer into a 100 ml volumetric flask.
Dilute to volume with chloroform and determine absorbance at 652 nm. Record on benchsheet.
Calculate the ug LAS in the sample by comparing the observed sample absorbance to the standard curve. Record on benchsheet.
Calculate ppm LAS in the sample (see Calculation section) and record on benchsheet.
A blank is run by using 100 ml of deionized water and carrying it through the analytical procedure. The blank is utilized to set the spectrophotometer baseline.

Calculation:

$$\text{ppm LAS} = \frac{\text{ug LAS}}{\text{Sample aliquote (ml)}}$$

Quality Control:

Samples requiring MBAS must be cooled to 4°C at the time of collection for proper preservation. The sample must be run within 48 hours of collection.

Prior to performing any analysis the analyst must prepare a standard curve. The curve is documented in the benchsheet notebook.

Standard curves should be updated no less frequently than once per quarter. The absorbances of the new standards when compared to the previous standard curve should produce values for ug LAS within ±10% of the expected value. If not, contact the supervisor.

Duplicate analysis are performed at a rate of not less than 10%

For each analytical session a 1 ug, 4 ug, and 10 ug LAS standard are determined. The values obtained must be within ±15% of the expected value.

Sample preservation is verified at log-in.

All standards and reagents preparation are documented in the benchsheet notebook.

HYDROLOGIC, INC.

Analytical Procedure

Title: Microbiological Waste Disposal	
Date issued: 23 March 1993	Supercedes:
Issued by:	

Safety: Lab Coat
Safety Glasses

Equipment: Autoclave bags
Autoclave

Procedure: All disposable contaminated microbiological is collected in the appropriately labeled receptacle. The receptacle should be lined with an autoclave bag.
When full the bag is removed and autoclaved at 121°C and 15 psig for one hour.
Remove from the autoclave, let cool, and dispose of in the usual manner.

HYDROLOGIC, INC.

Analytical Procedure

Title: Nitrate Nitrogen-Brucine Sulfanilic Acid	
Date issued: 18 Jan. 1993	Supercedes:
Issued by:	

Safety:

Lab Coat
Safety Glasses

Equipment:

Hot water bath
Cold water bath
Spectrophotometer
Test tubes
Pipets (various sizes)
Cuvets

Reagents:

13 N Sulfuric acid (H_2SO_4) *Preparation:* Place 125 ml of deionized water in a 1000 ml beaker. Slowly add 500 ml of concentrated sulfuric acid. Extreme caution should be exercised, the heat of solution is markedly exothermic.
Nitrate standard Ricca Cat. # 5457
Brucine sulfate reagent Ricca Cat # 1420

Procedure:

Standard curve:
Begin to heat hot water bath to 100°C. A good deal of time is required to achieve this temperature. Do not continue the analysis until the hot water bath reaches this temperature.
Dilute the nitrate stock standard ten time to produce an intermediate standard which is 100 ppm $N(NO_3)$. Into separate test tubes pipet 1.0, 2.0, 4.0, 7.0, & 10.0 ml of intermediate standard. Add sufficient water to bring the total volume to 10.0 ml. These test tubes correspond to 1.0 ug, 2.0 ug, 4.0 ug, 7.0 ug &10.0 ug $N(NO_3)$ respectively.
A blank is run concurrently using 10.0 ml of deionized water.
To each standard add 10 ml of 13 N H_2SO_4. Swirl to mix and place immediately in the cold water bath at 20°-25°C.
Allow test tubes to come to thermal equilibrium.
Add 0.50 ml of brucine sulfanilic acid solution to each tube and transfer to the hot water bath at 100°C. Accuracy of the test is incumbent on the hot water bath being 100°C. careful control of this is, therefore, required. Warm the test tubes for exactly 25 minutes.

After 25 minutes remove the tubes to the cold water bath and allow them to come to thermal equilibrium.
Using the blank set the baseline for the determination at 410 nm.
Determine the absorbance of each standard and record on the benchsheet. Draw the standard curve and archive in the benchsheet notebook.

Sample Determination:

Place 10.0 ml of sample or an aliquote diluted to 10.0 ml in a test tube. Record the sample volume on the benchsheet.
Add 10.0 ml of 13 N H_2SO_4, swirl to mix and place in the cold water bath at 20°-25°C. Allow the tube to come to thermal equilibrium.
Add 0.50 ml of brucine-sulfate solution to the sample and transfer to the hot water bath at 100°C. Warm for exactly 25 minutes.
After 25 minutes remove the tubes to the cold water bath and allow to come to thermal equilibrium.
Determine the absorbance of each solution at 410 nm and record the value on the benchsheet.
Determine the $N(NO_3)$ content by comparing the sample's absorbance against the standard curve. Record the value found on the benchsheet.

Calculation:

$$\text{ppm } N(NO_3) = \frac{\text{ug } N(NO_3)}{\text{Sample Aliquote (ml)}}$$

METHOD REFERENCES

"Methods of Chemical Analysis of Water and Wastes", U.S Environmental Protection Agency, EMSL, Cincinnati, OH, March 197 (EPA-600/4-79-020).

Standard Methods for Examination of Water and Wastewater, 15th Ed. 1981, American Public Health Association, Washington, D.C.

Hach Handbook of Water Analysis, 1979, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

Standard Methods for Examination of Water and Wastewater, 16th Ed., 1985, American Public Health Association, Washington, D.C.

"The Determination of Inorganic Anions in Water by Ion Chromatography", U.S. Environmental Protection Agency, EMSL, Cincinnati, OH 45260, March 1984 (EPA-600/4-84-817).

EPA 600 Series Methods, 40 CFR Part 136, Federal Register, Friday October 26, 1984.

"Test Methods for Evaluating Solid Waste", U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C., Second Edition, Revised, April 1984 (EPA SW-846).

Statement of Work for Organics Analysis, USEPA Contract Laboratory Program, 10/86.

Annual Book of ASTM Standards, American Society for Testing and Materials, 1980.

"Soil Survey of Laboratory Methods and Procedures for Collecting Soil Samples", Soil Conservation Service, Washington, D.C., 1972.

"Leaking Underground Storage Tank and Petroleum; Analytical and Quality Assurance Guidance", Wisconsin Department of Natural Resources, July 1993.

22.0 Standard Traceability

Whenever such materials are available, the lab uses NIST traceable standards for its reference comparisons. Requisitions for standard reference materials are kept on file. Vendor-supplied certificates are maintained on file that certify standard purity, QA information, and Traceability.

23.0 Laboratory Safety Procedures

Lab safety is an integral part of scientific work and is largely a matter of experience and common sense. However, it is the responsibility of anyone working in a technical environment to familiarize themselves with the safety rules, equipment, and hazards of their workplace. Lab technicians and analysts have special responsibilities in this area to promote and maintain a safe working environment.

Lab personnel can prevent most damage and injury by using good judgement based on sound safety information, following the safety guidelines of the lab, and asking questions about any aspect of their work about which they are unsure. Prevention of accidents is paramount.

To ensure proper safety reequirements, the Safety Director inspects the premises on a weekly basis. Figure 8 is the Laboratory Safety Inspection Form completed during the weekly inspections.

24.0 General Safety Procedures

The elements of the laboratory safety and chemical hygiene plan are detailed in the Chemical Hygiene Plan/Safety Manual document. This document is currently undergoing revision.

An outline of key elements presented in this document illustrating general safety procedures used by the lab appears below;

1. Special handling instructions for equipment are followed.
2. Safety equipment is located throughout the lab.
3. First aid and fire extinguisher equipment are readily available to lab personnel.
4. Safety practices of the lab are constantly monitored and improved to provide a safe working environment.
5. New employees are familiarized with the safety program, the CHO/SM, and possible hazards of their workplace.

LABORATORY SAFETY INSPECTION FORM
HYDROLOGIC - FRANKFORT, KY
WEEKLY REPORT

INSPECTION BY: **DATE:**

FIRE EXTINGUISHERS

SECURELY MOUNTED
LABLED CLEARLY
FULL AND INSPECTIN WITHIN LAST 6 MONTHS
ABC ONLY IN NON-EQUIPMENT AREAS
ACCESS NOT BLOCKED
EXTINGUISHERS IDENTIFIED

GC	SVOA	VOA	EXTRACT

SAFTY APPARTUS

FIRST AID AVAILABLE AND EASILY ACCESSIBLE
SPILL CLEANUP MATERIALS AVAILABLE
SAFETY SHOWERS OPERATIONAL
EYEWASH STATIONS OPERATIONAL
SHOWERS AND STATIONS UNBLOCKED
MATERIAL SAFTEY DATA SHEETS AVAILABLE
SPILL LOG FILED AND AVAILABLE
EMERGENCY LIGHTS FUNCTIONAL
EXIT SIGNS FUNCTIONAL, UNBLEOCKED

PERSONAL SAFTY

SAFETY GLASSES, FACE SHIELD, GOGGLES WORN
NO CONTACT LENSES WORN IN LAB
LAB APRONS / COATS WORN
ACID APRONS WORN WHERE NECESSARY
GLOVES SUITED FOR HAZARD
HAIR BELOW SHOULDER LENGTH TIED BACK
NO EX CESSIVE JEWELRY
RESPIRATORS WORN WHERE NECESSARY
RESPIRATORS MAINTAINED PROPERLY
NO FOOD OR DRINK IN LAB AREAS OR IN SAMPLE COOLER
NO SMOKING IN LAB AREAS

FUME HOODS

EXHAUST MOTOR WORKING
LIGHTS WORKING
SASH CURTAIN KEPT IN LOWERED POSITION
NO CLUTTER TO BLOCK EXHAUST
100 FPM AVERAGE FACE VELOCITY
ACCESS NOT BLOCKED
CONTAINERS LABELED PROPERLY
NO CHEMICAL SPILLS

LAB BENCH/WORK SURFACES

AREA NEAT AND ORDERLY
SINKS CLEAN AND ACCESSIBLE WHEN NOT IN USE
NO OPEN CONTAINERS UNATTENDED
CONTAINERS LABELED PROPERLY
NO LIQUID OR CHEMICAL SPILLS
NO LIQUIDS STORED ABOVE WAIST HEIGHT UNLESS
IN CLOSED STORAGE CABNET/AREA

GENERAL

NO BROKEN GALASSWARE IN USE
COMPRESSED GASES FIXED TO WALL OR BNECH
COMPRESSED GASES STORED /TRANSPORTED PROPERLY
NO LEAKS IN COMPRESSED GASES ATTACHED TO EQUIP
NO ELECTRICAL OR DATA CORDS IN / ACROSS WALKWAYS
NO OVERLOAD CONDITIONS ON ELECTRICAL CIRCUITS
INCOMPATIBLE CHEMICALS STORED SEPARATELY
PROPER DISPOSAL OF WASTE PRODUCTS
CHEMICAL/SAMPLE CONTAINERS HAVE TIGHT LIDS
EXITS AND DOORWAYS UNBLOCKED
WALKWAYS FREE OF OBSTACLES
BOXES NOT STACKED HIGHER THAN RECOMMENDED
NO EMPTY BOXES IN WORKING AREAS

GC	SVOA	VOA	EXTRACT

BROKEN GLASS CONTAINERS

ONLY BROKEN GLASS IN CONTAINERS
NO CHEMICALS OR LIQUIDS IN CONTAINERS
AREA CLEAN AROUND CONTAINERS

TRASH CANS

ONLY DISPOSABLE PRODUCTS IN TRASHCANS
NO BROKEN GLASS, CHEMICAL OR LIQUIDS IN CANS
CONTAINERS NOT OVERFLOWING

FLAMMABLE CHEMICAL STORAE

CABINETS PROPERLY IDENTIFIED WITH LABELS
ALL LARGE QUANTITIES (> 1 LITER) IN CABINETS
NO FLAMMABLE PRODUCTS NEAR HEAT SOURCES
CONTAINERS LABELED PROPERLY

NON-FLAMMABLE CHEMICAL STORAGE

STORAGE AREAS PROPERLY IDENTIFIED WITH LABELS
CONTAINERS PROPERLY LABELED

ACID STORAGE

CABINETS PROPERLY IDENTIFIED WITH LABELS
ALL LARGE QUANTITIES (> 1 LITER) IN CABINETS
CONTAINERS LABELED PROPERLY
ALL ACIDS STORED IN PROPER CABINETS

SATELLITE ACCUMULATION POINTS

INSPECTED FOR LEAKS
SECURITY INTACT
EXCESS FUMES
DRUMS IN GOOD CONDITION
SEALS IN TACT
LABELS CORRECT AND IN VIEW

REFRIGERATORS

REFRIGERATORS PROPERLY IDENTIFIED WITH LABELS
REFRIGERATORS CLEAN, ITEMS NEATLY STORED
SAMPLE CONTAINERS PROPERLY LABELED
HAZARDOUS SAMPLES PROPERLY LABELED

25.0 Laboratory Notebooks

Lab notebooks will serve as permanent records of tests performed in the lab. Notebooks should contain enough information about a particular analysis that another analyst can clearly understand what occurred during the test.

Ball point pens or pens with permanent ink are to be used for all notebook or logbook entries. Use of a pencil for this documentation is unacceptable. Corrections must be made by single-line strike outs and these authorized corrections must be initialed and dated. Obliteration and use of liquid paper for these documents is unacceptable.

Lab notebooks are used to document routine analyses and any observed irregularities. Unusual observations are to be noted. If the analyst deviates from the standard methodology, this is fully documented. Formulae used for each data set appear in the notebooks.

Computer calculation records are also considered records of analytical testing. These records shall be stored so as to facilitate retrieval and review if necessary It is not necessary to show each individual calculation.

Lab notebooks are periodically review by the Lab Director, QA/QC Officer, or Section Supervisor. The reviewer initials and dates each page of the notebook.

26.0 Glassware Cleaning

In general, lab glassware is cleaned with an approved laboratory detergent and thoroughly rinsed with deionized water. Containers are rinsed immediately after use with tap water to minimize build up of residues.

Lab personnel are required to properly dispose of any contents in the apparatus to be cleaned immediately after use and prior to washing the apparatus.

Glassware should be cleaned immediately after being used in the digestion, concentration, or analysis of samples.

ORGANIC glassware cleaning includes the following steps:

1. Rinse glassware with extraction solvent soon after use.
2. Scrub all surfaces of the glassware in hot water/lab detergent solution.
3. Rinse three times with tap water.
4. Rinse thoroughly with deionized water.
5. Air dry glassware and store properly.
6. Solvent rinse glassware with extraction solvent prior to use and allow to air dry.
7. Store clean glassware with aluminum foil caps. Aluminum foil should be solvent-rinsed.

Chipped, damaged, or broken glassware is to be immediately discarded and not used for subsequent analysis once such flaws are detected by lab personnel.

27.0 Employee Training Procedures

Personnel employed by the analytical lab must have the necessary attitudes, knowledge, and skills to do their job. This includes all job functions involving data quality from sample collection to data reporting.

Using prior experience or knowledge as the basis of action, an analyst can gain experience and problem solving through basic on-the-job training. This training evolves through various stages listed below:

1. Observation of experienced operators performing a task.
2. Actual performance of the task under direct supervision of an experienced analyst.
3. Continued measurement of analytical performance through Performance Evaluation samples and supervisory observation.

Required certification of personnel follow EPA and state certifying agency's recommendations for tenure and skill levels. Employees are encouraged to improve their professional credentials by attending courses at local colleges and universities. Instrument demonstrations and training courses are other ways that new skills can be acquired and implemented into lab operations. These courses contribute to the general skill level of the lab and assist the lab's effort to produce high quality data for all analytical testing.

The Section Supervisor is responsible for ensuring that an analyst learns a new procedure and completely understands that procedure prior to performing it on real analytical samples. This process includes:

1. Establishing analyst familiarity with the Standard Operating Procedure (SOP). This includes answering questions on the SOP and suggesting further references.
2. Guiding new employees through practice sample analysis.
3. Observation of performance and corrective suggestions.
4. Documentation of the training process.

A Training Documentation Form records this process and documents that an analyst has read and understands each procedure applicable to their jobs. Sample Log Books serve as a permanent and ongoing record of analytical performance. These logs are periodically reviewed as an aid to employee evaluation and further training. The Training Documentation Form (TDF) appears in Figure 9.

Training Check List for Lab Personnel

Employee Name: ______________________

Job Title: ______________________

Method or Item	SOP	Stds Prep		QC Data Pkg	Trainer Initials	Trainee Initials	Date

28.0 Laboratory Quality Control Procedures

An effective QA/QC Program is vital to the validity of analytical data produced by the lab. Many decisions are made based on quality analytical data. It is the responsibility of the lab to provide that data.

Sample collection, preservation, handling, storage, and analytical methodology are chosen with respect to precision, accuracy, and the specific needs of a given analytical project. Standard approved methods are used for analysis and any additional necessary analytical steps carefully documented.

The lab uses several measures of internal quality control to ensure data quality. These include blank, spikes, and duplicate analysis at required EPA frequencies. Analytical SOPs detail the number and frequency of these checks.

In general, the descriptions of the internal quality checks are as follows:

Method Blank Analysis: A method blank is a "clean" sample (i.e., containing no analyte of concern), most often distilled water, to which all reagents and analytical procedures are performed. Method blanks are analyzed at a rate of one per sample lot, every twenty samples, or daily. A method blank is carried through the entire analytical scheme. The method blank volume should be approximately equal to the sample volumes being processed. A method blank is used in all analyses to verify that the determined concentrations do not reflect contamination. If consistent high blanks are observed, laboratory glassware and reagents are checked for contamination and the analysis halted until the system is brought under control.

Organic Surrogate Spike Analyses: Each sample and blank is spiked with one or more "surrogate" compounds during preparation operations. These surrogate standards are chosen because they have properties similar to sample analytes of the same interest, but are most likely absent from the natural sample. This procedure is used to evaluate the ability of the analytical procedures to recover the true amount of a known compound.

The results of surrogate standard determinations are compared with the true values spiked into the sample matrix prior to extraction and analysis, and the percent recoveries of the surrogate standards are determined. Recoveries should be within the acceptable control limits as specified for each compound. If control limits are exceeded for surrogate standards, calculations are checked for errors. If calculations are correct, internal standards and surrogate spiking solutions are checked for degradation, contamination, or solvent evaporation. The instrument performance is then checked. If all previous items are acceptable, repurge or re-extraction of the sample maybe necessary depending on the situation and sample availability. If all other measures fail to reveal the reason for low surrogate recovery, check for matrix interfernce and recalibrate if necessary.

Matrix Spike/Matrix Spike Duplicate Analyses: To evaluate the effect of the sample matrix upon analytical methodology, two separate aliquot samples are spiked with a standard mix of compounds appropriate to a given analysis. The matrix spike/matrix

spike duplicate (MS/MSD) are analyzed at a frequency of one set per twenty samples. The percent recovery for the spiking compounds is calculated. The relative difference (RPD) between the MS/MSD is also calculated.

The observed percent recoveries and RPD between the MS/MSD are used to determine the accuracy and the precision of the analytical methods for the sample matrix. If the percent recovery and RPD results exceed the control limits as specified for each spiking compound, calculations are checked for errors. If no errors exist then a re-analysis is required unless a situation of matrix interference exists.

Organic Internal Standards: An Internal Standard is used to correct for variations due to sample injection techniques and some matrix interferences. Internal standards are added to the sample by the analyst, after extraction and before analysis at a frequency consistent with the method being used. The area counts of the Internal Standard are compared to the daily standard used to calibrate the instrument. If the Internal standard recovery falls outside of the acceptable control limits, the internal standard is checked for any degradation, contamination, or solvent evaporation. The operation of the system and its calibration is evaluated if the internal standard is deemed acceptable.

Duplicate Sample Analyses: Duplicate analyses are performed only for those parameters which do not permit matrix spike recovery determination to evaluate the reproducibility of the method. Results of the duplicate analyses are used to determine the relative percent difference (RPD) between replicate samples. For each parameter analyzed at least one duplicate sample is run per group of 20 samples. If possible, the duplicate analysis should be performed on a sample for which original result is above the detection limit.

A file of quality control samples of known concentration is maintained in the lab. This check standard bank is a valuable source of performance test samples, instrument performance check standards, and training sample spikes,duplicates, etc. A detailed listing of available quality control samples, their identity, and concentration is maintained in the file. Results of quality control samples document the validity of data and help control data quality within predetermined acceptance limits.

The following sections detail the types of quality control samples analyzed by the lab to validate the accuracy and precision of its measurements.

29.0 Performance Evaluation Standards

Performance Evaluation Standards provide interlaboratory comparison and are a valuable performance indicator for the lab. The lab routinely participates in the U.S. EPA Water Pollution (WP) audit program. Twice yearly results from these samples are used as a requirement for maintaining state certifications. Results are reviewed by the Lab Director, QA/QC Officer, and Section Supervisors with their assigned personnel. These standards are a valuable gauge of individual analyst performance under normal lab operating conditions.

If the lab fails in its ability to analyze samples of this type, the entire analytical measurement process shall be immediately examined to determine the cause of these errors. This process shall be documented and maintained as a part of these performance standard records.

30.0 Performance and System Audits

The Lab QA/QC Officer carries out two basic types of audits in order to ensure the production of high quality data by the lab. These are Systems Audits and Performance Audits. Each is explained below.

SYSTEM AUDITS are qualitative evaluations of all components of field and laboratory quality control measurement systems. They determine the effectiveness of the execution of these systems as designed. Such audits evaluate executed versus scheduled QA/QC activities for a given project. An example is the data management system audit in which only data collection and management activities are addressed.

PERFORMANCE AUDITS are a quantitative evaluation of the measurement systems of a program. Accuracy and precision are determined on samples of known composition in order to test a specific measurement system. This action may be overtly or covertly implemented by the QA Officer.

PRECISION is a term denoting the scatter of results around a target data point. Precision improves as scatter becomes smaller. Precision is measured as standard deviation and reported as relative percent difference.

ACCURACY is the degree of agreement of an analytical result with the true value. Systematic and random errors can influence accuracy. Accuracy of a given data set is determined from recovery of spiked samples and surrogates. Although spiked samples are an estimate due to matrix or method interference effects, they are used to determine accuracy acceptance limits. The overall accuracy for each compound is the arithmetic mean over all of the spiked samples.

The ACCURACY for each compound is calculated using the formula below:

$$A = (R-X)/T \times 100$$

where: A= recovery of the added spike

R= analytical result of the spiked sample in ug/l (ppb)

X= mean concentration of duplicate results

T= true value of the added spike

31.0 Evaluation of QA/QC Data

When the analysis of a sample set is completed, the results are reviewed and evaluated to access the validity of the data set. The Lab Director completes and documents this review process prior to the release of analytical data from the lab. The Lab Director's signature authorizes release to the client on each data report. A Data Evaluation Checklist documents this procedure as illustrated in Figure 10.

The Lab Director considers many factors in this evaluation. Some of these have been previously discussed in this document and are summarized in the following section:

1. Review of Accuracy and Precision measurements associated with this sample set.
2. Specific instrument checks.
3. Calibration data.
4. Operational parameters such as GC or GC/MS conditions.
5. Data history of site if available.
6. Internal logic of results.
7. Sampling data directly affecting results.

All laboratory data are routinely assessed for precision, accuracy, and completeness. Initially these evaluations are applied over a broad concentration range. As more data points are accumulated, precision and accuracy acceptance limits are developed to define accuracy and precision over specific concentration ranges.

A minimum of ten measurements of accuracy and precision are required to establish initial control limits. Twenty or more measurements shall be used thereafter to establish these limits.

In general, control limits of two standard deviations, a 95% Confidence Interval, shall be the Warning Limit and three standard deviations, a 99% Confidence Interval, shall be the Upper and Lower Control Limits for the test. Control Limits are updated as additional accuracy and precision data become available.

Control charts, if required by a state agency or requested by a specific client, are used to maintain a permanent record of the accuracy and precision of their data.

These charts make it easy for analysts to spot outliers or out of control events that generate non-acceptable data (data that does not meet established acceptance criteria). These charts also are valuable for illustrating trends in analytical data.

An OUTLIER is an extreme value, either high or low, which has questionable validity as a member of a measurement set. Outliers may be rejected from a data set in which a known experimental aberration occurred, or the data fails a statistical criterion called the "t" value.

Failure of this test occurs when the datum exceeds the tabulated two tailed students' t for t= 0.05 at n-1 degrees of freedom. The t value is calculated using the formula below:

$$t = (X - X1) / S$$

where: X1= the extreme value being statistically treated

X= the mean of the measurement set for n observations

S= the standard deviation associated with X

If the value is found to be an outlier and rejected, the mean and standard deviation are recalculated using the remaining values in the data set. This procedure is reiterated until no outliers remain.

HYDROLOGIC LABORATORY EQUIPMENT
UPDATED FEBRUARY 4, 1994

ITEM	MODEL	AGE(YR)
Gas Chromatograph/ Mass Spectrometer Column: DB5-MS 30m, 0.32mm ID Film Thickness: 1.0 microns Linear Velocity = 40 cm/sec Temperature Program = 45 deg. C for 5 min; 300 deg. C at a rate of 5 deg/min Autosampler: CTC A200S; 105 positions	Incos XL Finnigan	0
Gas Chromatograph/ Mass Spectrometer Column: Resteck RTX 502.2 105 m, 0.52mm ID Film Thickness: 1.0 microns Carrier Flow = 8 ml/sec Temperature Program = 75 deg. C for 4 min; 220 deg. C at a rate of 8 deg/min Autosampler: Tekmar LSC200/2016	4500 Finnigan	9
Gas Chromatograph/ Mass Spectrometer with Tremetrics 9000 series Gas Chromatograph Column: JW DB-5 MS 30m, 0.32mm ID Film Thickness: 1.0 microns Linear Velocity = 40 cm/sec Temperature Program = 45 deg. C for 5 min; 300 deg. C at a rate of 8 deg/min Autosampler: Tremetrics 774; 42 positions	1050 Finnigan	8
Gas Chromatograph/ Mass Spectrometer Column: Resteck RTX-1 60m, 0.53mm ID Film Thickness: 3.0 microns Carrier Flow = 8 ml/min Temperature Program = 45 deg. C for 5 min; 180 deg. C at a rate of 8 deg/min Autosampler: Tekmar LSC/ALS; 10 positions	3400 Varian	

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Gas Chromatograph/
ECD/Flame Ionization 9000 Tremetrics 1
Column: 3% SP-2100 on 100/120 Supleco Port
Carrier Flow = 30 ml/min
Temperature Program (FID) = 50 deg. C for 7 min; increase at a rate of 20 deg/min; 260 deg. C for 5.5 min.
Temperature Program (ECD) = 200 deg C for 40 min
Autosampler: Tremetrics 774; 42 positions

Gas Chromatograph/
Photo Ionization & 9000 Tremetrics 3
HECD & Flame Ionization
Column: J&W DB-VRX 75m, 0.45mm ID
FID: Vocal 30m, 0.52mm ID
Film Thickness: 1.0 microns
Carrier Flow = 8 ml/min
Temperature Program = 35 deg. C for 5 min; 180 deg. C at a rate of 5 deg/min, hold for 1 min.; 200 deg C at a rate of 10 deg/min. hold for 12 min.
Autosampler: Dynatech Dynasoil; 30 positions

Gas Chromatograph/
Electron Capture & 5890 Hewlett Packard
Flame Ionization
Column: Supleco Volcol 30m, 0.53mm ID
Film Thickness: 3.0 microns
Column: J&W DB-608 30m, 0.53mm ID
Film Thickness: 0.83 microns
Carrier Flow = 8 ml/min
Temperature Program (FID) = 60 deg. for 7 min.; 200 deg. C at a rate of 15 deg/min, hold for 2.5 min.
Temperature Program (ECD) = 140 deg. C for 1 min; 240 deg. C at a rate of 15 deg/min, hold for 7 min.; 265 deg C at a rate of 6 deg/min. hold for 13 min.
Autosampler: Hewlett Packard 7673a; 100 positions &
Dynatech PTA30NS; 30 positions

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Gas Chromatograph/
Photo Ionization & HECD — 3400 Varian
- Column: J&W DB-624 75m, 0.53mm ID
- Film Thickness: 0.83 microns
- Carrier Flow = 8 ml/min
- Temperature Program = 20 deg. C for 5 min; 180 deg. C at a rate of 10 deg/min, hold for 10 min.

Autosampler: Dynatech Dynasoil; 30 positions

Gas Chromatograph/
Photo Ionization & Flame Ionization — 3400 Varian
- Column: J&W DB-624 75m, 0.53mm ID
- Film Thickness: 1.0 micron
- Carrier Flow = 8 ml/min
- Temperature Program = 70 deg. C for 5 min; 200 deg. C at a rate of 15 deg/min, hold for 2 min.

Autosampler: Dynatech PT30WS; 30 positions

Gas Chromatograph/
Flame Ionization & Flame Ionization — 3400 Varian
- Columns: 3% SP-2100 on 100/120 Supleco Port
- Carrier Flow = 30 ml/min
- Temperature Program = 50 deg. C for 7 min; 250 deg. C at a rate of 20 deg/min, hold for 10 min.

Autosampler: Tremetrics 774; 42 positions

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Certification:

HydroLogic-Frankfort is certified in the following states and areas:

State	Category	Certification Number
Georgia	Wastewater/UST	N/A
Indiana	Drinking Water - Organics	C-KY-03
Kentucky	Drinking Waster - Organics	00065
New Jersey	Wastewater	58957
North Carolina	Wastewater/Groundwater	399
Oklahoma	Wastewater/UST	9430
South Carolina	Wastewater	70002
Tennessee	UST Parameters	N/A
West Virginia	Wastewater/UST	093

Methodology:

HydroLogic-Frankfort strictly adheres to methodology for the 500 and 600 Series published by the Environmental Protection Agency. HydroLogic-Frankfort also performs work according to SW846 procedures.

Quality Control:

HydroLogic-Frankfort has a Quality Assurance Manual and Standard Operating Procedures Manual. These procedures and guidelines are strictly adhered to for the assurance of accurate data. Both of these manuals are available upon request.

Containers and Shipping:

HydroLogic-Frankfort supplies all containers, chain of custody documents, labels, preservatives, coolers, and bubble wrap to clients who request these items. All containers are shipped new to avoid any contamination problems. A temperature blank is included in each cooler sent out and is requested to be returned with each cooler in order to assure proper preservation of all samples. containers received at the laboratory are never reused but disposed of according to Federal and State Hazardous Wastes regulations.

HydroLogic-Frankfort ships and receives samples through transportation services of Federal Express and United Parcel Services. All shipments are on a priority overnight basis. HydroLogic assumes the responsibility of cost for all shipping cost to and from our facilities. After receipt a fax will be sent confirming the receipt and expected completion date of the project. The project manager or the sample custodian will phone to eliminate and discrepancies if needed.

Invoices:

Invoices will be sent in the same envelope with the hard copy of each project upon completion.

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FIGURE 1. QUALITY ASSURANCE PROGRAM

OVERVIEW

OPERATION	PROCEDURE	AUDIT	FREQUE
Sample Preparation		- Method Blank	1
		- Spike	2
		- Duplicate	2
		- Reagents	5
Sample Analysis	GC	- Standard Mix	3
	GC/MS	- Mass Calibration	3
		- Response Calibration	3
		- Standards	3
Data Reduction	GC, Qualitative	- GC Retention Times	4
		- Verification By Second Analysis	4
	GC, Quantitative	- Peak Measurement	4
		- Calculations	4
	GC/MS, Qualitative	- Computer Match	4
		- Reference Spectra	4
		- GC Retention Times	4
	GC/MS, Quantitative	- Peak Measurement	4
		- Calculations	4
Data Reporting		- Completeness	1
		- Accuracy	1

FREQUENCY CODES:

1 once per project
2 once per 20 samples
3 daily
4 in every case
5 as new reagents are received

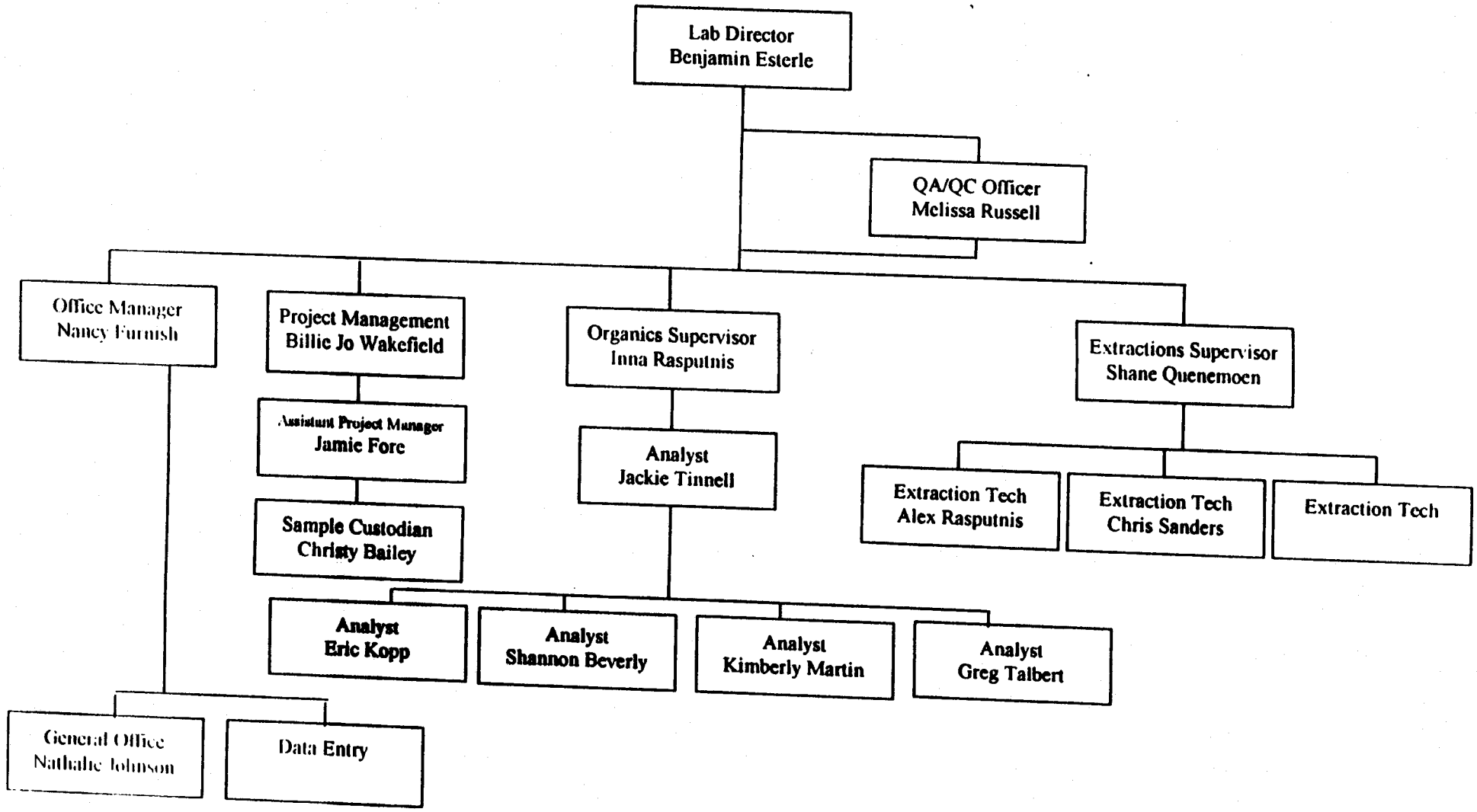

Lab Director
Benjamin Esterle
QA/QC Officer
Melissa Russell
Office Manager
Nancy Furnish
Project Management
Billie Jo Wakefield
Organics Supervisor
Inna Rasputnis
Extractions Supervisor
Shane Quenemoen
Assistant Project Manager
Jamie Fore
Analyst
Jackie Tinnell
Extraction Tech
Alex Rasputnis
Extraction Tech
Chris Sanders
Extraction Tech
Sample Custodian
Christy Bailey
Analyst
Eric Kopp
Analyst
Shannon Beverly
Analyst
Kimberly Martin
Analyst
Greg Talbert
General Office
Nathalie Johnson
Data Entry

Figure 2

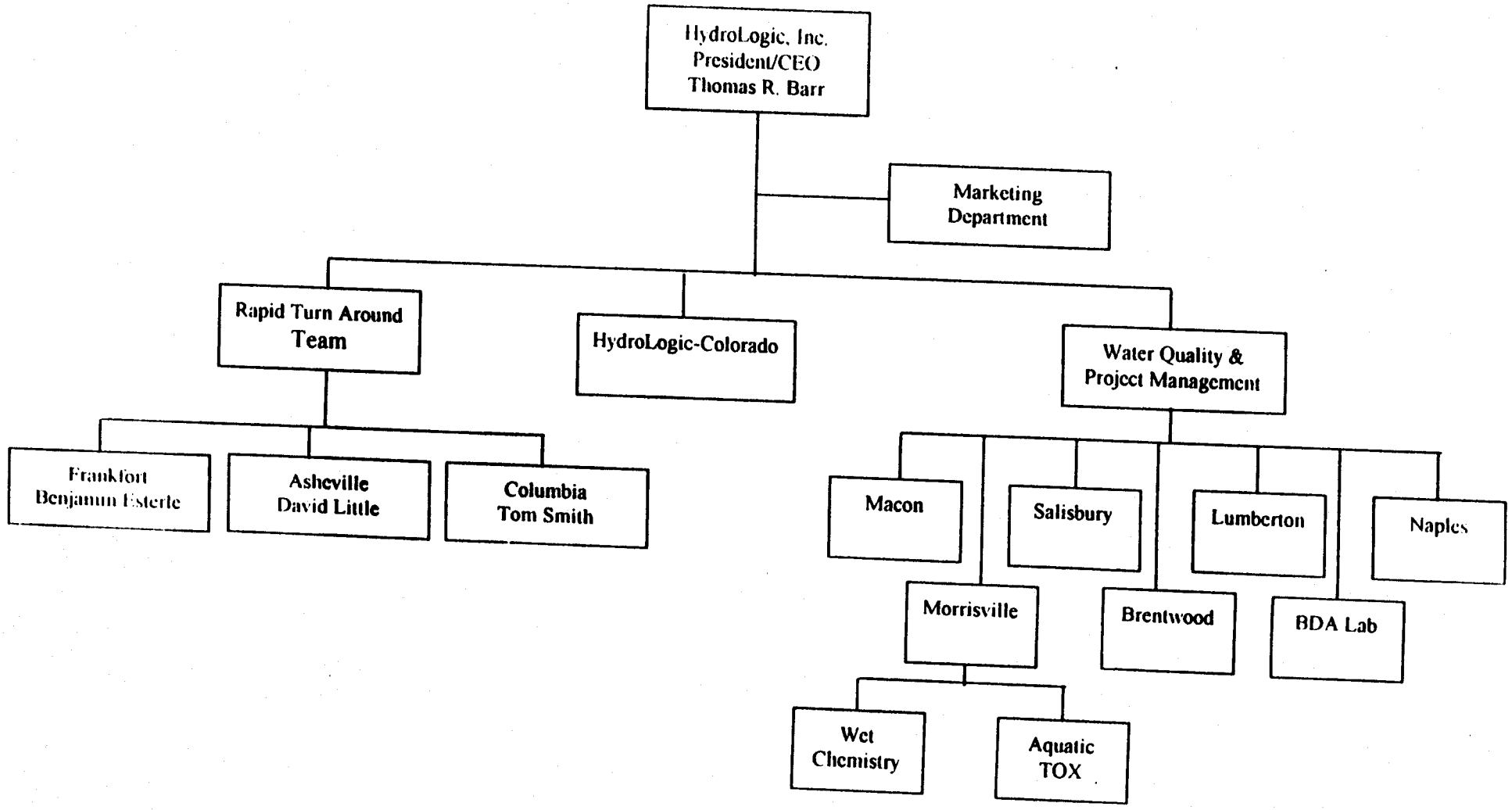

HydroLogic, Inc.
President/CEO
Thomas R. Barr
Marketing Department
Rapid Turn Around Team
HydroLogic-Colorado
Water Quality & Project Management
Frankfort
Benjamin Esterle
Asheville
David Little
Columbia
Tom Smith
Macon
Salisbury
Lumberton
Naples
Morrisville
Brentwood
BDA Lab
Wet Chemistry
Aquatic TOX

Figure 3

3.0 LABORATORY FACILITIES/EQUIPMENT

The Chemistry Section of the lab occupies roughly 4500 sq. ft. The lab is equipped with advanced Gas Chromatograph instrumentation and support instrumentation essential to a modern environmental facility. Figures 4 and 5 represents a floor plan of the lab detailing office and lab space.

Access to the lab is limited to authorized personnel. During normal working hours, access to the lab is through the monitored reception area at the lab entrance. Visitors are required to be accompanied by a lab employee while in the building.

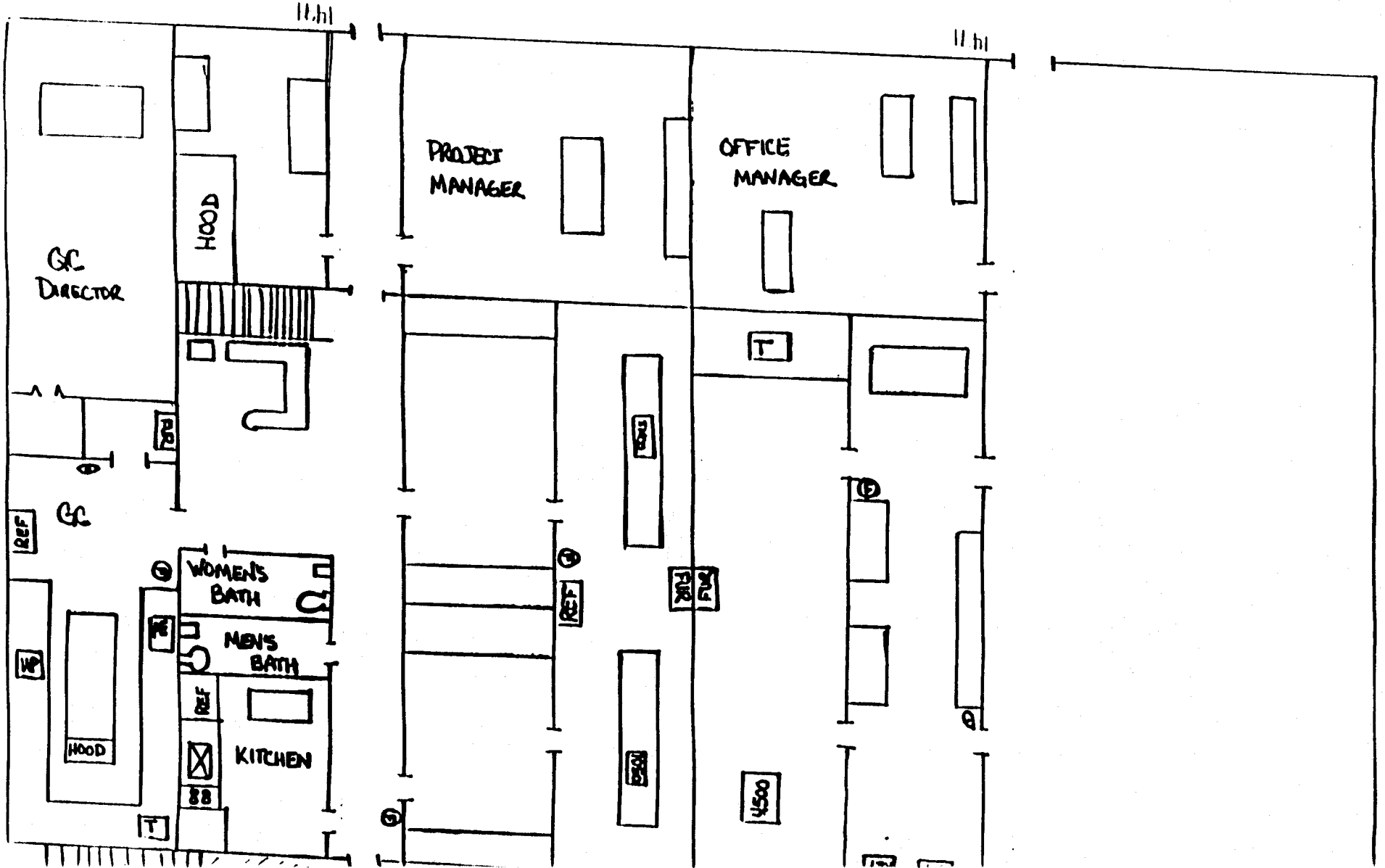
The lab is equipped with advanced instrumentality for the fast, accurate and precise analyses of environmental samples. A listing of equipment appears in Figure 6.

Figure 6. Major Laboratory Equipment

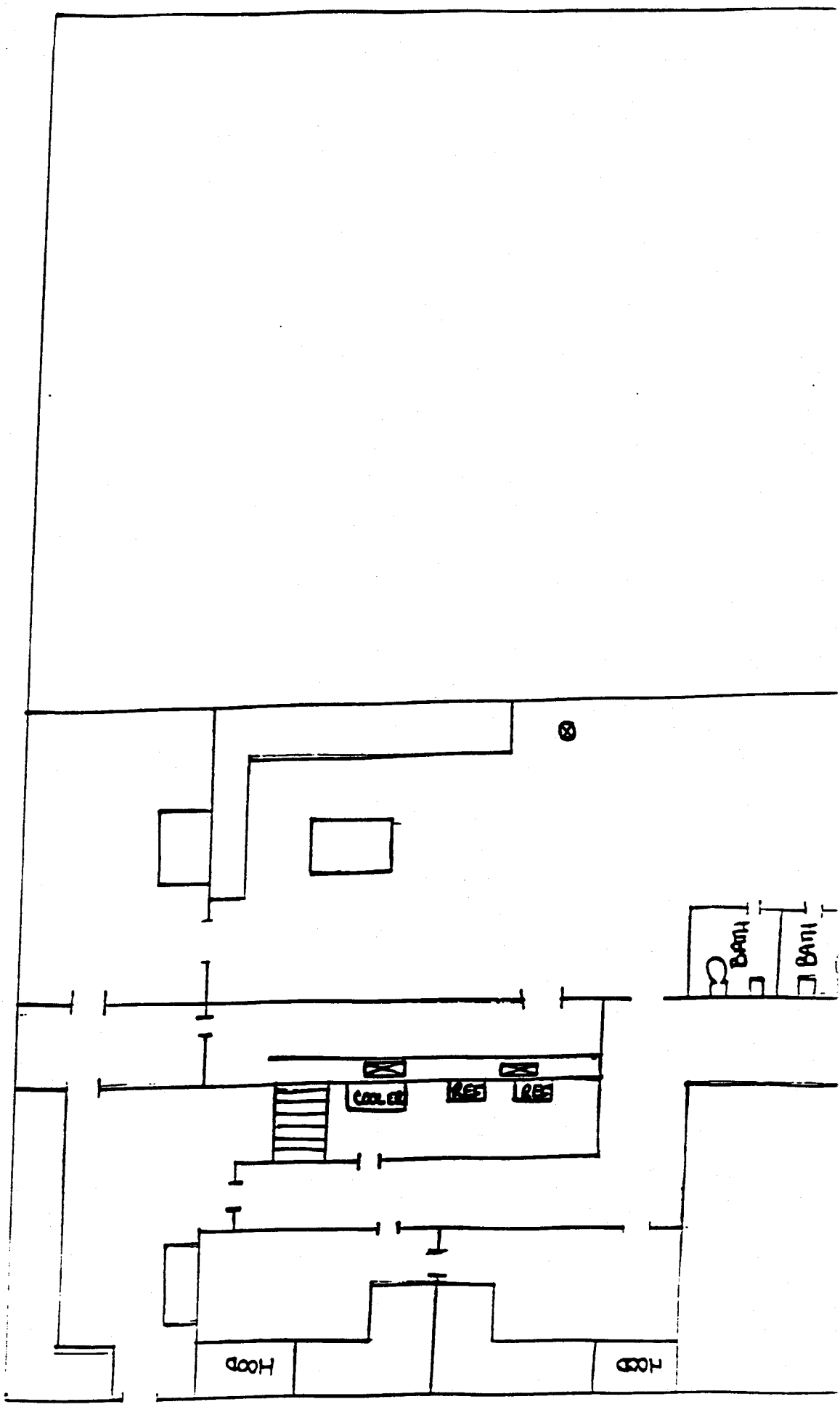
Item	Model	Age(yr)
Gas Chromatograph/ Mass Spectrometer	Incos XL Finnigan	0
Gas Chromatograph/ Mass Spectrometer	4500 Finnigan	9
Gas Chromatograph/ Mass Spectrometer	1050 Finnigan	8
Gas Chromatograph/ Mass Spectrometer	3400 Varian	
Gas Chromatograph/ Flame Ionization Auto Sampler	9000 Tremetrics	1
Gas Chromatograph/ Electron Capture	8300 Perkin Elmer	8
Gas Chromatograph/ Photo Ionization & HECD & Flame Ionization	9000 Tremetrics	2.5
Gas Chromatograph/ Flame Ionization	5890 Hewlett Packard	0
Gas Chromatograph/ Photo Ionization & HECD & Flame Ionization	Varian 3400	
Gas Chromatograph/ Photo Ionization HECD & Flame Ionization	Varian 3400	

4.0 SAMPLE COLLECTION/CUSTODY/TRACKING

Special consideration is given to the procurement, storage, and transportation of environmental samples to be analyzed. Hydrologic-Frankfort does not supply services for sampling, however, often supplies containers and preservatives for clients. U.S. EPA protocols are followed for containers, amounts, types,



PROJECT MANAGER
OFFICE MANAGER
HOOD
GC DIRECTOR
GC
REF
WOMEN'S BATH
MEN'S BATH
KITCHEN
HOOD
T
4500


BATH
BATH
REF
REF
HOOD
HOOD

methodology, and sample holding times. Procedures ensure that analytes originally present in the sample matrix do not undergo degradation or concentration, and that contaminants which might interfere with the analysis have not been added. The following are examples of these procedures.

1. Plastic containers are avoided for samples which will be analyzed by Electron Capture Detectors due to possible phthalate contamination.
2. Metal containers are avoided since they may contain trace impurities such as oil films, lacquers, or rosin from soldered joints which can interfere with GC testing.
3. Glass bottles/jars with teflon-lined lids or aluminum foil are used as the most generally suitable sample containers.
4. Special preservatives are added during sample collection as necessary to counter effects such as analyte instability and/or possible matrix interactions.
5. Preservatives are added to samples upon collection whenever possible. Addition upon receipt is documented.
6. Trip blanks of laboratory pure water are prepared and sent out with prepared sample containers as an indicator of possible contamination.
7. Surrogates such as a,a,a-Trichlorofluorotoluene are added to UST samples upon analysis in order to confirm proper functioning of the analysis system.

Appendix A summarizes sample container requirements, preservatives, and holding times. Chain of Custody forms are completed for all samples. An example of this form appears in Figure 7.

The Lab Director or his representatives are responsible for the following items on samples:

1. Ensure that appropriate sampling equipment is used.
2. Ensure that appropriate sample containers are used.
3. Ensure that samples are collected, preserved, and transported in a correct and timely manner.
4. Ensure that all sample tracking documentation is correct.

5.0 Sample Receipt/Log-In

Samples submitted to the lab are received by the sample custodian(s) in the sample receiving area. Samples are checked against the Chain of Custody for discrepancies. The Lab Director is contacted to clarify noted discrepancies, clients are contacted directly as necessary, and comments that effect the sample in question are noted on the Chain of Custody remarks section. If no problems are noted with the samples, the custodian(s) signs the Chain of Custody record and logs in the samples.

COMPANY NAME _____ CONTACT NAME _____ TELEPHONE NO. _____

Samplers Print Name _____ Signature _____

Project No _____

SAMPLE ID	SAMPLE LOCATION	Composite	Grab	Date	Time	Sample Type: Water	Liquid	Oil	Solid	No. of Containers	ANALYSIS	REMARKS

COMMENTS: _____

Relinquished by (Signature) _____

Relinquished by (Signature) _____

Relinquished by (Signature) _____ Date _____ Time _____

Received by: (Signature) _____

Received by: (Signature) _____ Date _____ Time _____

Received for Laboratory by: _____ Date _____ Time _____

Samples are recorded upon receipt in the Hydrologic LIM system and identified by assignment of unique sample ID numbers A DAILY printout of this log stands as a hardcopy record of sampl receipt activity of the lab. Samples are processed through the la using this number.s

A summary of the Laboratory Information Management (LIMS system follows this section. Completed analytical sample record and associated QA/QC are maintained on computer storage medium such as discs and electronic data files of raw chromatographic runs. Logging functions, sample labels, multiple and custom report formatting, sample status and tracking, and bench sheet generation are some of this system's capabilities. The system is called LABTROL and was developed as a customized LIMS for the Hydrologic group of laboratories. Detailed information on each sample also appears on the Chain of Custody form. This information includes:

1. Sample ID
2. Sample Location (Client ID)
3. Sample Type, Date and Time Collected
4. Number of Containers
5. Analyses Requested
6. Remarks

6.0 Custody in the Laboratory

Once received in the lab, samples are placed in a secure storage area accessed only by lab personnel. Custody is defined by the following criteria. A sample is in the custody of the lab if:

1. It is in the possession of an analyst.
2. It is in the analyst's view after physical possession.
3. The sample was in an analyst's physical possession and was sealed or locked to prevent tampering.
4. If the sample is in a secured area of the lab.

In order to satisfy these custody provisions, the following procedures are implemented by the lab.

1. Samples are stored in a secure area of the lab.
2. Lab access is only through a monitored reception area.
3. Visitors are escorted by lab personnel while in the lab.
4. Samples remain in the secure storage area until removed for sample preparation and subsequent analysis.
5. Custody is the responsibility of an analyst removing a sample from storage.
6. Each analyst must return samples to the secure storage area before the end of the working day.

7.0 Sample Tracking

Samples are tracked through the lab using the unique sample number assigned during log-in. This number is affixed to t unique samples.

Associated sample preparation, analysis records, a associated QA/QC documentation is keyed to this ID number.

In summary, this system consists of Chain of Custoc information, sample log-in information, computer generated analys and QA/QC information, instrument operations notebooks, instrume printouts, and final analytical reports. This tracking syste ensures valid, defensible, data that is well documented in al stages of generation.

Samples shall be returned to the client for final disposition unless alternative arrangements (and charges) are made.

8.0 Document Control Procedures

Accountable documents used by the lab include logbooks, Chai of Custody records, bench sheets, data system printouts, and othe documents relating to the sample or its analysis. The lab has established the following document control procedures to ensure that documentation is thorough and retrievable.

1. All observations and surrogate recovery results recorded by the lab are entered into permanent lab logbooks organized by parameter.
2. The responsible analyst shall sign and date each page of entry. Entries shall be maintained in chronological order.
3. Instrument run logs are maintained to provide data on run sequences of individual instruments.
4. Entries in logbooks are to be made in black ink.
5. Corrections are made by crossing a single line through the error. All changes are dated and initialed.

Before analytical results are released to the client, the lab assembles and cross-checks information on relevant sample documentation to ensure consistency and data validity. No copies of data, other than confidential file copies, will be generated without approval of the client.

9.0 Data Files

Raw chromatographic data analysis files are archived and stored. LIMS information is also continually updated with new project configurations/definitions. Older sample information is stored on disc or tape cartridge backup.

No sample files or associated documentation are to be destroyed without the direct approval of the Lab Director. Wastewater data is also maintained for a minimum of ten years. Data is annually archived in storage boxes and electronic files packed for long-term storage to facilitate re-access and retrieval if necessary.

10.0 Detection Limits

A detection limit is the smallest concentration for which there is at least a 95% chance that an analyte will be detected as a positive value. Thus, at this level, there is only a 5% chance of obtaining a false negative. The Minimum Detection Limit (MDL) is statistically defined per U.S. EPA analysis methodology.

Frankfort protocols call for a compound reporting limit to be based on the Practical Quantitation Limit (PQL) of a given compound. This level signifies the actual attainable detection/quantitation level achievable by a given analyst using specific instrumentation.

The lab reports are based on determined PQL values for specific compounds. Low end report limits are based on specific equipment operating under approved conditions per methodology. Actual reported detection limits are also matrix and type (water,soil) dependent. These limits will be altered to reflect necessary dilution factors. A table of typical reported PQLs (Table 1) for water samples is included after this section.

TABLE 1 TYPICAL PQLs

Test Name: bna-62 Matrix: water Method: 625
Department: ms Components: 56 Hold Time To Extract: 7d

Component	DAS	Units	AMDL
Phenol	108-95-2	ug/l	5.0
bis(2-Chloroethyl)ether	111-44-4	ug/l	5.0
2-Chlorophenol	95-57-8	ug/l	5.0
1,3-Dichlorobenzene	541-73-1	ug/l	5.0
1,4-Dichlorobenzene	106-46-7	ug/l	5.0
1,2-Dichlorobenzene	95-50-1	ug/l	5.0
bis(2-Chloroisopropyl)ether	39638-32-9	ug/l	5.0
N-Nitroso-di-n-propylamine	621-64-7	ug/l	5.0
Hexachloroethane	67-72-1	ug/l	5.0
Nitrobenzene	98-95-3	ug/l	5.0
Isophorone	78-59-1	ug/l	5.0
2-Nitrophenol	88-75-5	ug/l	5.0
2,4-Dimethylphenol	105-67-9	ug/l	5.0
bis(2-Chloroethoxy)methane	111-91-1	ug/l	5.0
2,4-Dichlorophenol	120-83-2	ug/l	5.0
1,2,4-Trichlorobenzene	120-82-1	ug/l	5.0
Naphthalene	91-20-3	ug/l	5.0
Hexachlorobutadiene	87-68-3	ug/l	5.0
4-Chloro-3-methylphenol	59-50-7	ug/l	5.0
2,4,6-Trichlorophenol	88-06-2	ug/l	5.0
2-Chloronaphthalene	91-58-7	ug/l	5.0
Dimethylphthalate	131-11-3	ug/l	5.0
Acenaphthylene	208-96-8	ug/l	5.0
Acenaphthene	83-32-9	ug/l	5.0
2,4-Dinitrophenol	51-28-5	ug/l	25.0
4-Nitrophenol	100-02-7	ug/l	25.0
2,4-Dinitrotoluene	121-14-2	ug/l	5.0
2,6-Dinitrotoluene	606-20-2	ug/l	5.0
Diethylphthalate	84-66-2	ug/l	5.0
4-Chlorophenyl-phenylether	7005-72-3	ug/l	5.0
Fluorene	86-73-7	ug/l	5.0
4,6-Dinitro-2-methylphenol	534-52-1	ug/l	25.0
4-Bromophenyl-phenylether	101-55-3	ug/l	5.0
Hexachlorobenzene	118-74-1	ug/l	5.0
Pentachlorophenol	87-86-5	ug/l	25.0
Phenanthrene	85-01-8	ug/l	5.0
Anthracene	120-12-7	ug/l	5.0
Di-n-butylphthalate	84-74-2	ug/l	5.0
Fluoranthene	206-44-0	ug/l	5.0
Pyrene	129-00-0	ug/l	5.0
Butylbenzylphthalate	85-68-7	ug/l	5.0
3,3-Dichlorobenzidine	91-94-1	ug/l	10.0
Benzo(a)anthracene	56-55-3	ug/l	5.0
bis(2-Ethylhexyl)phthalate	117-81-7	ug/l	5.0
Chrysene	218-01-9	ug/l	5.0

Di-n-octylphthalate	117-84-0	ug/l	5.0
Benzo(b)fluoranthene	205-99-2	ug/l	5.0
Benzo(k)fluoranthane	207-08-9	ug/l	5.0
Benzo(a)pyrene	50-32-8	ug/l	5.0
Indeno(1,2,3-cd)pyrene	193-39-5	ug/l	5.0
Dibenz(a,h)anthracene	53-70-3	ug/l	5.0
Benzo(g,h,i)perylene	191-24-2	ug/l	5.0
Hexachlorocyclopentadiene	77-47-4	ug/l	10.0
N-Nitrosodiphenylamine	86-30-6	ug/l	10.0
Benzidine	92-87-5	ug/l	80.0
N-Nitrosodimethylamine	62-75-9	ug/l	10.0

Test Name: mvoa-624 Matrix: water Method: EPA 624
Department: ms Components: 31 Hold Time: 14d

Component	CAS	Units	AMDL
Chloromethane	74-87-3	ug/l	5.0
Bromomethane	74-83-9	ug/l	5.0
Vinyl Chloride	75-01-4	ug/l	5.0
Chloroethane	75-00-3	ug/l	5.0
Methylene Chloride	75-09-2	ug/l	5.0
Trichlorofluoromethane	75-69-4	ug/l	5.0
1,1-Dichloroethene	75-35-4	ug/l	1.0
1,1-Dichloroethane	75-34-3	ug/l	1.0
trans-1,2-Dichloroethene	156-60-5	ug/l	2.0
Chloroform	67-66-3	ug/l	1.0
1,2-Dichloroethane	107-06-2	ug/l	1.0
1,1,1-Trichloroethane	71-55-6	ug/l	1.0
Carbon Tetrachloride	56-23-5	ug/l	1.0
Bromodichloromethane	75-27-4	ug/l	1.0
1,2-Dichloropropane	78-87-5	ug/l	1.0
cis-1,3-dichloropropene	10061-01-5	ug/l	5.0
Trichloroethene	79-01-6	ug/l	1.0
Dibromochloromethane	124-48-1	ug/l	1.0
1,1,2-Trichloroethane	79-00-5	ug/l	1.0
Benzene	71-43-2	ug/l	1.0
trans-1,3-Dichloropropene	10061-02-6	ug/l	5.0
2-Chloroethyl vinyl ether	110-75-8	ug/l	5.0
Bromoform	75-25-2	ug/l	1.0
Tetrachloroethene	127-18-4	ug/l	1.0
1,1,2,2-Tetrachloroethane	79-34-5	ug/l	1.0
Toluene	108-88-3	ug/l	1.0
Chlorobenzene	108-90-7	ug/l	1.0
Ethylbenzene	100-41-4	ug/l	1.0
1,2-Dichlorobenzene	95-50-1	ug/l	5.0
1,3-Dichlorobenzene	541-73-1	ug/l	5.0
1,4-Dichlorobenzene	106-46-7	ug/l	5.0

Test Name: 608 Matrix: water Method: EPA 608
Department: gc Components: 26 Hold Time to Extract: 7d

Component	CAS	Units	AMDL
alpha-BHC	319-84-6	ug/l	0.05
beta-BHC	319-85-7	ug/l	0.05
delta-BHC	319-86-8	ug/l	0.05
gamma-BHC (Lindane)	58-89-9	ug/l	0.05
Heptachlor	76-44-8	ug/l	0.05
Aldrin	309-00-2	ug/l	0.05
Heptachlor epoxide	1024-57-3	ug/l	0.05
Endosulfan I	959-98-8	ug/l	0.05
Dieldrin	60-57-1	ug/l	0.1
4,4'-DDE	72-55-9	ug/l	0.1
Endrin	72-20-8	ug/l	0.1
Endosulfan II	33213-65-9	ug/l	0.1
4,4'-DDD	72-54-8	ug/l	0.1
Endosulfan sulfate	1031-07-8	ug/l	0.1
4,4'-DDT	50-29-3	ug/l	0.1
Endrin Ketone	53494-70-5	ug/l	0.1
Chlordane	57-74-9	ug/l	0.5
Toxaphene	8001-35-2	ug/l	1.0
Endrin aldehyde	7421-93-4	ug/l	0.1
Aroclor-1016	12674-11-2	ug/l	0.5
Aroclor-1221	11104-28-2	ug/l	0.5
Aroclor-1232	11141-16-5	ug/l	0.5
Aroclor-1242	53469-21-9	ug/l	0.5
Aroclor-1248	12672-29-6	ug/l	0.5
Aroclor-1254	11097-69-1	ug/l	1.0
Aroclor-1260	11096-82-5	ug/l	1.0

Test Name: herb-8150 Matrix: water Method: EPA 8150
Department: gc Components: 3 Hold Time to Extract: 7d

Component	CAS	Units	AMDL
2,4-D	94-75-7	ug/l	10.0
2,4,5-TP(Silvex)	93-72-1	ug/l	2.0
2,4,5-T	93-76-5	ug/l	2.0

Test Name: gvoa-601 Matrix: water Method: EPA 601
Department: gc Components: 29 Hold Time to Extract: 14d

Component	CAS	Units	AMDL
Bromodichloromethane	75-27-4	ug/l	1.0
Bromoform	75-25-2	ug/l	1.0
Bromomethane	74-83-9	ug/l	1.0
Carbon Tetrachloride	56-23-5	ug/l	1.0
Chlorobenzene	108-90-7	ug/l	1.0
Chloroethane	75-00-3	ug/l	1.0
2-Chloro Ethyl Vinyl Ether	110-75-8	ug/l	1.0
Chloroform	67-66-3	ug/l	1.0
Chloromethane	74-87-3	ug/l	1.0

Dibromochloromethane	124-48-1	ug/l	1.0
1,2-Dichlorobenzene	95-50-1	ug/l	1.0
1,3-Dichlorobenzene	541-73-1	ug/l	1.0
1,4-Dichlorobenzene	106-46-7	ug/l	1.0
Dichlorofluoromethane	75-43-4	ug/l	1.0
1,1-Dichloroethane	75-34-3	ug/l	1.0
1,2-Dichloroethane	107-06-2	ug/l	1.0
1,1-Dichloroethene	75-35-4	ug/l	1.0
trans-1,2-Dichloroethene	156-60-5	ug/l	1.0
1,2-Dichloropropane	78-87-5	ug/l	1.0
cis-1,3-Dichloropropene	10061-01-5	ug/l	1.0
trans-1,3-Dichloropropene	10061-02-6	ug/l	1.0
Methylene Chloride	75-09-2	ug/l	1.0
1,1,2,2-Tetrachloroethane	79-34-5	ug/l	1.0
Tetrachloroethene	127-18-4	ug/l	1.0
1,1,1-Trichloroethane	71-55-6	ug/l	1.0
1,1,2-Trichloroethane	79-00-5	ug/l	1.0
Trichloroethene	79-01-6	ug/l	1.0
Trichlorofluoromethane	75-69-4	ug/l	1.0
Vinyl Chloride	75-01-4	ug/l	1.0

Test Name: 602-full Matrix: water Method: EPA 602
Department: gc Components: 8 Hold Time: 14d

Component	CAS	Units	AMDL
Benzene	71-43-2	ug/l	1.0
Chlorobenzene	108-90-7	ug/l	1.0
1,2-Dichlorobenzene	95-50-1	ug/l	1.0
1,3-Dichlorobenzene	541-73-1	ug/l	1.0
1,4-Dichlorobenzene	106-46-7	ug/l	1.0
Ethylbenzene	100-41-4	ug/l	1.0
Toluene	108-88-3	ug/l	1.0
Xylene (Total)	1330-20-7	ug/l	1.0

11.0 Significant Figures

A uniform method of rounding and reporting numbers has been established by EPA. These criteria appear in the EPA HANDBOOK OF ANALYTICAL QUALITY CONTROL IN WATER AND WASTEWATER LABORATORIES, EPA-600/4-79-019. An excerpt from this document appears in Appendix B of this manual. This method shall be utilized unless otherwise specified in sample documentation.

12.0 General Laboratory Practice

Many analytical procedures performed by the lab are specific to a particular analysis type or instrument. Whenever possible the analytical methods used by the lab are from agencies such as the U.S. Environmental Protection Agency (USEPA), American Public Health Association (APHA), American Society for Testing and Materials (ASTM), the National Institute for Occupational Safety and Health (NIOSH), and Standard Methods.

Only approved methodology shall be used for the generation of regulatory data as listed in section 40 CFR of the Federal Register and its updates.

Analysts shall implement new procedures only after thorough testing in the lab using standards, spikes, and duplicates as controls. Once the procedure is adequately defined and statistically in control, the method may be actually used for sample analysis in the lab.

The following sections will describe general procedures such as calibration, preventive maintenance, supply control, safety, and training.

13.0 Calibration Standards

Internal and Surrogate standards are obtained from reputabl chemical suppliers with certification of purity and concentratio These commercial materials are used as stock standards. Workir concentrations are made from stocks to cover the linear range c specific calibration curves. Calibration check standards fr different vendor sources are used as a QA measure.

All standard preparation documentation is kept in a Standarc Notebook. The following information is defined for each compour or mixture of compounds:

1. Standard Number/Source/Lot Number
2. Preparation date
3. Name of each compound and aliquot used
4. Standard Concentration
5. Final Concentration
6. Solvent used
7. Final volume
8. Preparer

Standard containers are labeled with the standard number. Al stock standards are checked for expiration dates and respons compared to that attained on previous materials as a QA measure.

14.0 Calibration Procedures

The following general calibration procedures are routinely performed by the lab. Specific calibration procedures for a particular instrument are detailed in each analytical method. Periodic calibrations are performed on equipment such as balances, thermometers, and waterbaths as detailed below. All calibration measurements are recorded in logbooks.

1. Analytical balances are checked daily by use of Class S weights and calibrations recorded.
2. The balance is serviced and calibrated under service contract on a yearly basis.
3. The temperature of water baths, ovens, and refrigerators is checked daily and recorded.
4. Thermometers are calibrated yearly against a certified NBS thermometer.
5. pH meters are calibrated daily using manufacture's instructions and readings of buffers recorded.
6. Analytical Balance is calibration-checked daily using a Class S or equivalent certified weight.

15.0 Preventive Maintenance Procedures

The manufacture's instrument manual serves as guidance o preventive maintenance such as lubrication, detector and sourc cleaning, and their frequency. Chromatographic injector septa carrier gas purification traps, and injector liners are replaced o a regular basis to maintain proper instrument response. Trends i sample and QA data are used to spot instrument response reductio or malfunction. Maintenance must be performed by qualifie personnel when instrument performance indicates degradation of the analytical system.

Symptoms of this degradation include the following:

1. Degradation of peak resolution
2. Degradation of compound response
3. Shift in calibration curves
4. Decreased sensitivity
5. Failure to meet defined QC criteria

Preventive Maintenance Logbooks are maintained on each analytical instrument. These logbooks contain detailed schedules for routine service functions. They also serve as a service history of the instrument.

Instrument downtime is minimized by maintaining adequate supplies of expendable items such as gas tanks, line filters, septa, syringes, GC columns, ferrules, computer paper, printer heads/ribbons, etc.

16.0 Hood Air Flow

The minimum allowable air face velocity for hoods is 100 cfm. Each hood is marked for the allowable sash opening. Adequacy of this flow is determined at time of installation and verified by flagging the air flow constantly. This ensures proper air movement at each hood and ensures proper personnel protection from fume exposure. The air face velocity is monitored once per month.

17.0 Equipment Maintenance

Maintenance and repair for lab instrumentality is documente in a looseleaf Equipment Maintenance Logbook. This bo establishes records of equipment problems and aids in t recognition of consistent problems. It also gives a genera indication of expected analytical performance.

The following items must be completed on the form in th Equipment/Maintenance Logbook:

1. Manufacturer:	Enter the name of the manufacturer of the particular equipment item
2. Model Number:	Enter specific model number o the item
3. Serial Number:	Enter the serial number of the item.
4. Date:	Enter the date of the problem or action.
5. Type of Service:	Enter a brief description of the problem along with your initials.
6. Service Action/Report:	Detail the corrective action required to restore the item to normal operating conditions.
7. Initials:	Analysts should initialize the repair as completed by the lab or service personnel.

The records of the Equipment Maintenance Logbook will provide valuable information on the durability of the equipment, lab personnel capabilities, trends in equipment operation, and the evaluation of the manufacturer and the effectiveness of their service personnel. The equipment maintenance records are maintained in the logbook concurrently with the preventive maintenance records in the same log book.

18.0 Balance Calibration

An analytical balance is used to prepare reference solution for stock or pure chemicals. All analytical results are based on the accuracy of the prepared reference solutions. Therefore the analytical balance must be properly maintained and operated. The following procedures are used to ensure that this is achieved:

1. Accuracy, Precision, and Sensitivity are checked yearly by a qualified balance specialist.
2. The balance is used on a heavy shock-proof table or counter.
3. Balance is located away from heavy lab traffic and drafts.
4. The inside and outside of the balance is kept clean.
5. Class S Weights or their equivalents are used to verify performance on a daily basis.

The manufacture's literature should be consulted by all first-time users of the balance. If deviations from accepted values occurs on Class S Weights, notify the Lab Director immediately. A visit by a qualified balance specialist may be required.

19.0 Thermometer Calibration

All thermometers used in the lab are calibrated when purchase and yearly thereafter. The thermometers are calibrated against NBS reference thermometer in the operational range of the device Temperature calibration tags are placed on the thermometer at th time of calibration.

20.0 Supply Quality Control

The production of quality analytical data is based on man factors. Essential to this is the specification of the chemica standards, equipment, and reagents used by the lab. Materials o equipment not meeting requirements of approved analytica methodology are not considered for use by the lab. Purchase decisions must be approved by the Lab Director or his representative to ensure this.

Lab reagents are poured from stock bottles in measured amounts for immediate use. Remaining or excess solution is not to be poured back into stock containers due to possible contamination.

All lab supplies shall be of required quality to ensure proper instrument calibration and performance. Many approved analytical methods detail the type and grade of acceptable materials, and these guidelines must be followed.

All reagents used by the lab are prepared from Analytical Reagent Grade (AR) chemicals or higher. The preparation of all reagents is documented for source, weight, and dilution. Reagents are clearly labeled with the composition, concentration, date prepared, preparer's initials, expiration date, any special storage requirements, date received, and date opened for use by the lab.

Reagents are stored in appropriate containers under conditions necessary to maintain their chemical integrity. Reagents are discarded after they have exceeded their shelf life.

Dry reagents such as glass wool, sodium sulfate, alumina, and silica gel are either heated to 400 degrees C or solvent extracted prior to use for organic chemical analysis.

Organic free water for the lab is purchased commercially. Analysis of blanks provides continuing quality checks.

Pesticide Grade organic solvents are used by the lab for organic testing. Solvents and reagents are checked for contamination using reagent blanks before they are used for actual samples.

All Quality Control Reference Materials (QCRMs) are acquired from reputable vendor sources or sources commonly used by the U.S. EPA. All organic standard materials and working standards are detailed in the Standards Logbook. These preparations are identified by unique ID numbers, and labeled for reference. A single page in this logbook should be used for single standards that are a mixture of other components. Several working standards may appear on a single page if they result from serial dilutions of only one standard.

Gases used by the laboratory are to be equal or superior i: quality to those described in approved analytical methodology. Extra tanks of primarily used gases shall be maintained in storage by the lab.

Gas dryers are used to prevent moisture contamination of GC and GC/MS equipment. Drying chemicals must be routinely replaced.

Glassware used for analytical testing shall be Class A.

21.0 Analytical Procedures

The lab uses approved methods from the U.S. EPA, APHA, SM, ASTM, and NIOSH as appropriate to the analysis of environmental samples. Prior to lab implementation, new procedures are tested using blanks, spikes, and duplicates as controls. Once properly understood by the analyst and quality data production is achieved, the method is documented and approved for use in the lab by the Lab Director. These analytical procedures are reviewed and updated periodically as needed. The methods routinely used by the lab are selected from the publications listed in Table 6.

TABLE 2

ROUTINELY USED METHODS

1. Annual Book of ASTM Standards Part 31-Water. ASTM. 1981. American Society for Testing and Materials. Philadelphia, PA 19103.

2. Collection and Analysis of Purgeable Organics Emitted from Wastewater Treatment Plants. U.S. EPA, Cincinnati, Ohio, 1980. Plublication No. EPA-600/2-80-017.

3. Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; U.S. EPA, 1984, Federal Register, 40CFR Part 136.

4. Handbook for Analytical Quality Control in Water and Wastewater Laboratories, U.S. EPA 1977. Publication No. EPA-600/4-79-019.

5. Hankbook for Sampling and Sample Preservation of Water and Wastewater. U.S. EPA, Cincinnati, Ohio 1982. Publication No. EPA-600/4-82-029.

6. Laboratory Protocols for Evaluating the Fate of Organic Chemicals in Air and Water, U.S. EPA, Athens, GA, 1982, Publication No. EPA-600/3-82-022.

7. Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples, U.S. EPA, Research Triangle Park, N.C., 1980, Publication No. EPA-600/8-80-038.

8. Manual of Analytical Quality Control for Pesticides and Related Compounds, U.S. EPA, Research Triangle Park, N.C., 1979, Publication No. EPA-600/1-79-008.

9. Manual of Chemical Methods for Pesticides and Devices, U.S. EPA, Office of Pesticide Programs, Beltsville, Maryland, 1982.

10. Methods of Analysis of the Association of Official Analytical Chemist, 14th Edition, 1985.

11. Methods for Chemical Analysis of Water and Wastes, U.S. EPA, Cincinnati, Ohio, 1979, Publication No. EPA-600/4-79-020.

12. Methods for Organic Chemical Analysis for Municipal and Industrial Wastewater. U.S. EPA, Cincinnati, Ohio, 1982. Publication No. EPA-600/4-82-057.

13. NIOSH Manuals of Analytical Methods, Vols. 1-7, National Institute for Occupational Safety and Health, Cincinnati, Ohio 1981.

TABLE (Continued)

14. Procedures for Handling and Chemical Analysis of Sediment and Water Samples, U.S. EPA, 1981, Technical Report EPA/CE-81-1.9

15. Standard Methods for the Examination of Water and Wastewater, Water Pollution Control Federation, 16th Edition, 1985.

16. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. Office of Solid Waste, U.S. EPA, Washington, DC, SW-846, 3rd Edition, 1986.

17. The Analysis of Polychlorinated Biphenyls in Transformer Fluid and Waste Oil, U.S. EPA/EMSL, Cincinnati, Ohio.

HYDROLOGIC

DATA EVALUATION CHECKLIST

CLIENT:

SAMPLE ID NUMBERS:

CONFIRMATION OF CHAIN-OF-CUSTODY ☐ YES ☐ NO INITIALS___

ASSIGNED LOG NUMBERS CHECK ☐ YES ☐ NO INITIALS_____

NUMERICAL TRANSCRIPTION/UNITS

HISTORICAL DATA CHECK

INTERNAL REPORT PARAMETER LOGIC:

PERMIT LIMITS: ☐ AVAILABLE ☐ NOT AVAILABLE ☐ CHECK OF LIMITS

INITIALS_____

REFERRED TO:

REASON:

SIGNATURE _____

32.0 Data Reports

Format and content of final data reports are dependent upon project requirements. These requirements determine the need for explanatory text,
or agency required reporting formats.

PQLs are reported if the detected value is less than the detection limit established by the lab. Data are generally reported in a tabular format available in the LIMS. Footnotes are referenced to specific data if explanations of reported data are required.

All reports are signed by the Laboratory Director, QA/QC Officer, or their designated representative.

Reported data from subcontracted labs is reported on laboratory reports along with the Frankfort Lab ID Number of the lab completing the testing. Only reputable labs are used for these services.

33.0 Quality Assurance/Quality Control Officer

The QA/QC Officer provides routine reports to management regarding lab operations, performance of measurement systems, and data quality. Associated document copies or raw data are incorporated into these records as necessary.

Reports should cover results of interlaboratory and intralaboratory precision/accuracy studies, results of system and performance audits, and data quality assessments.

Any significant problems affecting data quality must immediately be brought to the attention of the Lab Director. Appropriate corrective action shall be implemented and evaluated for its effectiveness in solving the problem.

The QA/QC Officer must ensure that any problem requiring corrective action is fully resolved. This is documented using a corrective action form (Figure 11). This form indicates the problem, the cause, and the corrective action necessary to solve the problem. The following procedures are noted in this evaluation system:

1. Identify the problem.
2. Assign investigative responsibility.
3. Determine the cause of the problem.
4. Determine necessary corrective action.
5. Implement the corrective action.
6. Verify elimination of the problem.

Documentation of this action is maintained on file in the lab.

34.0 Manual Review

This QA/QC Manual and other SOP Manuals are periodically reviewed by upper management and the QA/QC Officer. Manuals are updated as necessary.

Revisions are distributed to all affected personnel and documentation is secured to show that revisions are understood and implemented.

HYDROLOGIC-KENTUCKY

LABORATORY DEVIATION FORM

HYDROLOGIC-KENTUCKY ID

DATE COLLECTED

CLIENT

SAMPLE MATRIX

FORM INITIATED BY

PROBLEM DESCRIPTON/SUSPECT PARAMETERS:

SUMMARY OF DATA REVIEW/ANALYST INQUIRY

FINAL DATA STATUS (A/R, REASONS)

RESULTING ACTION

APPROVED BY:

DATE:

APPENDIX A

Containers, Preservation, Hold Times

Parameters	Recommended Volume (ml)	Container	Preservative	Holding Time
Physical Properties				
Color	125	P, G	Cool, 4° C	48 hours
Conductance	125	P, G	Cool, 4° C	28 days
Hardness	125	P, G	HNO_3 to pH < 2	6 months
Odor	200	G only	Cool, 4° C	24 hours
pH	50	P, G	None	Immediately
Residue, Filterable	250	P, G	Cool, 4° C	7 days
Residue, Nonfilterable	250	P, G	Cool, 4° C	7 days
Residue, Total	250	P, G	Cool, 4° C	7 days
Residue, Volatile	250	P, G	Cool, 4° C	7 days
Settleable Matter	1000	P, G	Cool, 4° C	48 hours
Temperature	1000	P, G	None	Immediately
Turbidity	100	P, G	Cool, 4° C	48 hours
Metals				
Dissolved	250	P, G	Filter on site HNO_3 to pH < 2	6 months
Total	500	P, G	HNO_3 to pH < 2	6 months
Hexavalent Chromium	250	P, G	Cool, 4° C	24 hours
Mercury, Dissolved	250	P, G	Filter on site HNO_3 to pH < 2	28 days
Mercury, Total	250	P, G	HNO_3 to pH < 2	28 days

HYDROLOGIC LABORATORIES

Analytical Rate Schedule & Laboratory Services

Parameters	Recommended Volume (ml)	Container	Preservative	Holding Time
Inorganic Non-metallic				
Acidity	250	P, G	Cool, 4° C	14 days
Alkalinity	250	P, G	Cool, 4° C	14 days
Bicarbonate	100	P, G	Cool, 4° C	14 days
Bromide	250	P, G	None	28 days
Carbonate	100	P, G	Cool, 4° C	14 days
Chloride	125	P, G	None	28 days
Residual Chlorine	500	P, G	None	Immediately
Coliform, Fecal	100	Ster. P,G	Ster. P, G	6 hours
Coliform, Total	100	Ster. P,G	Ster. P, G	6 hours
Corrosivity (Langlier Index)	350	P, G	Cool, 4° C	Immediately
Cyanides (5,6)	1000	P, G	Cool 4° C, NaOH to pH > 12, 0.6g ascorbic acid	14 days
Fluoride	500	P only	None	28 days
Iodide	125	P, G	Cool, 4° C	24 hours
Nitrogen, Ammonia or Ammonia (as N)	1000	P, G	Cool, 4° C H_2SO_4 to pH < 2	28 days
Nitrogen, Total Kjeldahl	1000	P, G	Cool, 4° C H_2SO_4 to pH < 2	28 days
Nitrate plus Nitrite	250	P, G	Cool, 4° C H_2SO_4 to pH < 2	28 days
Nitrate (as N)	250	P, G	Cool, 4° C	48 hours
Nitrite (as N)	125	P, G	Cool, 4° C	48 hours
Dissolved Oxygen	300	G only	None	Immediately
Phosphorus Ortho-phosphate	125	P, G	Filter on site Cool, 4°C	48 hours
Phosphorus, Total	125	P, G	Cool, 4° C 2 H_2SO_4 to pH < 2	28 days
Phosphorus, Total, Dissolved	125	P, G	Filter on site H_2SO_4 to pH < 2	28 days
Resistivity	100	P, G	Cool, 4° C	28 days
Silica (Silicon Dioxide)	125	P only	Cool, 4° C	28 days
Sulfate	125	P, G	Cool, 4° C	28 days
Sulfide	1000	P, G	Cool, 4° C, 2ml Zn Acetate, NaOH to > 9	7 days
Sulfite	125	P, G	None	Immediately

HYDROLOGIC LABORATORIES

Analytical Rate Schedule & Laboratory Services

Parameters	Recommended Volume (ml)	Container	Preservative	Holdin
Organics				
BOD	1000	P, G	Cool, 4° C	48 hours
COD	125	P, G	Cool, 4° C H_2SO_4 to pH < 2	28 days
Oil and Grease	2 x 1000	G only	Cool, 4° C H_2SO_4 to pH < 2	28 days
Phenols (Phenolics)	250	G only	Cool, 4° C H_2SO_4 to pH < 2	28 days
MBAS (Surfactants)	500	P, G	Cool, 4° C	48 hours
Total Organic Carbon	125	G only	H_2SO_4 to pH < 2	28 days
Total Recoverable Pet. Hydrocarbons	2 x 1000	G only	H_2SO_4 to pH 2	14 days
Volatiles, (Purgeable)	2 x 40	G only	Cool, 4° C	14 days
Semi-Volatiles	2500	G only	Cool, 4° C	7 days for ex 40 days for a
Pesticides & PCBs	2500	G only	Cool, 4° C	7 days for ex 40 days for a
Total Organic Halides	250	G (Amber)	Cool, 4° C H_2SO_4 to pH < 2	7 days
Purgeable Halocarbons	2 x 40	G, Teflon lined septum	Cool, 4° C 0.008% $Na_2S_2O_3$[6]	14 days
Purgeable Aromatics	2 x 40	G, Teflon lined septum	Cool, 4° C 0.008% $Na_2S_2O_3$[6] HC1 to pH < 2	14 days
Acrolein and Acrylonitrile	2 x 40	G, Teflon lined septum	Cool, 4° C 0.008% $Na_2S_2O_3$[6] Adjust pH to 4-5	14 days
Phthalate Esters	2500	G, Teflon lined cap	Cool, 4° C	7 days for extr 40 days to ana
PCBs	2500	G, Teflon lined cap	Cool, 4° C	7 days for extr 40 days to ana

APPENDIX B

Parameters	Recommended Volume (ml)	Container	Preservative	Holding
Organics (continued)				
Chlorinated Herbicides	2500	G, Teflon lined cap	Cool, 4° C	7 days for extr 40 days for a
Chlorinated Hydrocarbons	2500	G, Teflon lined cap	Cool, 4° C	7 days for extr. 40 days for a
TCDD	2500	G, Teflon lined cap	Cool, 4° C 0.008% $Na_2S_2O_3$	7 days for extra 40 days for an
Radiological Tests				
Alpha, beta and radium	2500	P, G	HNO_3 to pH < 2	6 months

DATA HANDLING AND REPORTING

Introduction

To obtain meaningful data on water quality, the sample collector must obtain representative sample and then deliver it unchanged for analysis. The analyst must perform the proper analysis in the prescribed fashion, complete calculations, and convert results to final form for permanent recording of the analytical data in meaningful, exact terms. These results are transferred to a storage facility for future interpretation and use.

The following sections discuss processing of actual values, recording and reporting of data in the proper way, some means of quality control of data, and the storage and retrieval of data.

The Analytical Value

Significant Figures

The term "significant figure" is used, sometimes rather loosely, to describe a judgment of the reportable digits in a result. When the judgment is not soundly based, meaningful digits are lost or meaningless digits are reported. On the other hand, proper use of significant figures gives an indication of the reliability of the analytical method used.

The following discussion describes the process of retention of significant figures.

A number is an expression of quantity. A figure or digit is any of the characters 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, which, alone or in combination, serve to express a number. A significant figure is a digit that denotes the amount of the quantity in the particular decimal place in which it stands. Reported analytical values should contain only significant figures. A value is made up of significant figures when it contains all digits known to be true and one last digit in doubt. For example, if a value is reported as 18.8 mg/l, the 18 must be firm while the 0.8 is somewhat uncertain, but presumably better than one of the values 0.7 or 0.9 would be.

The number zero may or may not be a significant figure depending on the situation.

Final zeros after a decimal point are always meant to be significant figures. For example, to the nearest milligram, 9.8 g is reported as 9.800 g.

Zeros before a decimal point with nonzero digits preceding them are significant. With no preceding nonzero digit, a zero before the decimal point is not significant.

If there are no nonzero digits preceding a decimal point, the zeros after the decimal point but preceding other nonzero digits are not significant. These zeros only indicate the position of the decimal point.

Final zeros in a whole number may or may not be significant. In a conductivity measurement of 1,000 μmho/cm, there is no implication by convention that the conductivity is 1,000 ± 1 μmho. Rather, the zeros only indicate the magnitude of the number.

When one number is subtracted from another, rounding off should be completed after the subtraction operation, to avoid possible invalidation of the operation.

When two numbers are to be multiplied, all digits are carried through the operation, then the product is rounded off to the number of significant digits of the multiplier with the fewer significant digits.

When two numbers are to be divided, the division is carried out on the two numbers using all digits. Then the quotient is rounded off to the number of significant digits of the divisor or dividend, whichever has the fewer.

When a number contains n significant digits, its root can be relied on for n digits, but its power can rarely be relied on for n digits.

Rounding Off the Results of a Series of Arithmetic Operations

The preceding rules for rounding off are reasonable for most calculations; however, when dealing with two nearly equal numbers, there is a danger of loss of all significance when applied to a series of computations that rely on a relatively small difference in two values. Examples are calculation of variance and standard deviation. The recommended procedure is to carry several extra figures through the calculations and then to round off the final answer to the proper number of significant figures.

Glossary of Statistical Terms

To clarify the meanings of statistical reports and evaluations of water quality data, the following statistical terms are introduced. They are derived in part from usage (1.2) of the American Society for Quality Control.

Accuracy—The difference between an average value and the true value when the latter is known or assumed.

Arithmetic mean—The arithmetic mean (or average) of a set of n values is the sum of the values divided by n:

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Bias—A systematic error due to the experimental method that causes the measured values to deviate from the true value.

Confidence limit, 95 percent—The limits of the range of analytical values within which a single analysis will be included 95 percent of the time.

$$95 \text{ percent CL} = \bar{X} \pm 1.96S$$

where CL is the confidence level and S is the estimate of the standard deviation.

A good measure of the significance of one or more zeros interspersed in a number is to determine whether the zeros can be dropped by expressing the number in exponential form. If they can, the zeros may not be significant. For example, no zeros can be dropped when expressing a weight of 100.08 g in exponential form; therefore the zeros are significant. However, a weight of 0.0008 g can be expressed in exponential form as 8×10^{-4} g, so the zeros are not significant. Significant figures reflect the limits in accuracy of the particular method of analysis. It must be decided whether the number of significant digits obtained for resulting values is sufficient for interpretation purposes. If not, there is little that can be done within the limits of the given laboratory operations to improve these values. If more significant figures are needed, a further improvement in method or selection of another method will be required.

Once the number of significant figures obtainable from a type of analysis is established, data resulting from such analyses are reduced according to set rules for rounding off.

Rounding Off Numbers

Rounding off of numbers is a necessary operation in all analytical areas. It is automatically applied by the limits of measurement of every instrument and all glassware. However, when it is applied in chemical calculations incorrectly or prematurely, it can adversely affect the final results. Rounding off should be applied only as described in the following sections.

Rounding-Off Rules

If the figure following those to be retained is less than 5, the figure is dropped, and the retained figures are kept unchanged. As an example, 11.443 is rounded off to 11.44.

If the figure following those to be retained is greater than 5, the figure is dropped, and the last retained figure is raised by 1. As an example, 11.446 is rounded off to 11.45.

If the figure following those to be retained is 5, and if there are no figures other than zeros beyond the five, the figure 5 is dropped, and the last-place figure retained is increased by one if it is an odd number or it is kept unchanged if an even number. As an example, 11.435 is rounded off to 11.44, while 11.425 is rounded off to 11.42.

Rounding Off Arithmetic Operations

When a series of numbers is added, the sum should be rounded off to the same number of decimal places as the addend with the smallest number of places. However, the operation is completed with all decimal places intact, and rounding off is done afterward. As an example,

$$\begin{array}{r} 11.1 \\ 11.12 \\ +11.13 \\ \hline 33.35 \end{array}$$

The sum must be rounded off to 33.4.

Series—A number of test results with common properties that identify them uniquely.

Skewness—A measure of the asymmetry of a frequency distribution,

$$K = \frac{(X_i - \bar{X})^3}{n\sigma^3}$$

This measure is a pure signed number. If the data are perfectly symmetrical, the skewness is zero. If K is negative, the long tail of the distribution is to the left. If K is positive, the long tail extends to the right.

Standard deviation—The square root of the variance of the universe.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} X_i^2 - \left(\sum_{i=1}^{N} X_i\right)^2 / N}{N}}$$

Standard deviation estimate—The most widely used measure to describe the dispersion of a set of data. Normally $\bar{X} \pm S$ will include 68 percent, and $\bar{X} \pm 2S$ will include about 95 percent of the data from a study:

$$S = \sqrt{\frac{\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2 / n}{n - 1}}$$

Standard deviation, single analyst—A measure of dispersion for data from a single analyst that is calculated here using an equation developed by Youden for his nonreplicate study design (3).

$$S_r = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{2(n - 1)}}$$

where D = the difference in paired values obtained from a single analyst.

Universe—The total set of items or measurements.

Variable—An experimentally determined estimate denoted X for a particular quality or trait of the population.

Quality control:

Those samples for wastewater nitrate only should be chilled to 4°C at the time of collection as preservation and analyzed within 48 hours of collection.

All other analysis of which nitrate is a part should be preserved by chilling to 4°C and adding H_2SO_4 to pH < 2 at the time of collection. The sample must be analyzed within 28 days of collection.

Duplicate analysis must be run at a rate of not less than 10%.

For each analytical session the 1.0 ug, 4.0 ug and 10.0 ug standard must be run as a minimum requirement. Upon comparison to the standard curve agreement must be within ± 20% of the standard's value.

A standard curve must be prepared by each analyst prior to running samples. The curves must be updated no less than once per quarter.

A performance standard of known concentration is analyzed during each analytical session. The value determined should be within ±20% of the vendor's published value.

Sample preservation is verified at log in.

Standards and reagents preparation are documented in the benchsheet notebook.

HYDROLOGIC, INC.

Analytical Procedure

Title: Nitrite Nitrogen	
Date issued: 19 Jan. 1993	Supercedes:
Issued by:	

Safety:

Safety glasses
Lab coat

Equipment:

Spectrophotometer
Pipets (various sizes)
Tripour beakers
Cuvets
Volumetric flasks 50 ml

Reagents:

Nitrite standard Ricca Cat.# 5460
Sulfanilamide Reagent Ricca Cat.# 8103
Naphthylethylenediamine dihydrochloride Ricca Cat.# 5230

Procedure:

Standard Curve

Dilute stock nitrite standard by pipeting 2.0 ml to a 500 ml volumetric flask and diluting to volume with distilled water. The solution is 1 ug/ml $N(NO_2)$.

Prepare working standards by pipeting appropriate aliquotes of the 1 ug/ml $N(NO_2)$ standard into a 50 ml volumetric flask and diluting to volume. The resulting standards should by 0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, and 10.0 ug $N(NO_2)$.

Transfer each standard to a 150 ml beaker and add 1 ml of sulfanilamide to each standard, mix, and let stand for 8 minutes. Then add 1 ml of naphthylethylenediamine dihydrochloride reagent to each solution, mix and let stand a minimum of 8 minutes. Determine the absorbance of each standard at 540 nm and record the standard concentration and absorbance on the benchsheet. The absorbance determination must be performed within 2 hours of the addition of the last reagent. A blank is prepared using 50 ml of deionized water and carried through the above outlined reagent additions. The blank should be used to set the baseline for the analysis.

Prepare a standard curve by plotting ug $N(NO_2)$ against absorbance. Store curve in appropriate benchsheet notebook.

Sample determination:

Place 50.0 ml of sample or an aliquote diluted to 50 ml into a 150 ml beaker. Record sample volume on the benchsheet.

To each sample add 1 ml of sulfanilamide reagent, mix and let stand for 8 minutes.

Then add 1 ml of napthylethlenediamine dihydrochloride to each sample, mix and let stand a minimum of 8 minutes.

Determine the absorbance of each sample at 540nm. The absorbance determination must be performed within 2 hours of the addition of the final reagent. Record absorbance on the benchsheet.

Determine the $N(NO_2)$ content in the sample by comparing the absorbance found against the standard curve. Record value found on the benchsheet in micrograms $N(NO_2)$.

Calculation:

$$\text{ppm } N(NO_2) = \frac{\text{ug } N(NO_2) \text{ found}}{\text{sample vol. (ml)}}$$

Quality Control:

Those sample for nitrite only should be chilled to 4°C at the time of collection and analyzed within 48 hours of collection.

All other analysis of which nitrite is a part should be preserved by chilling to 4°C and adding H_2SO_4 to pH < 2 at the time of collection. The sample must be analyzed within 28 days of collection.

Duplicate analysis must be run at a rate of not less than 10%.

Each analyst must prepare a standard curve prior to running any analysis. The curve must be updated quarterly as a minimum requirement.

For each analytical session a 0.5, 2.0, and 10.0 ug $N(NO_2)$ standard must be determined. The absorbance observed must be within $\pm$ 10% of the value expected when compared to the standard curve. If not, a new standard curve must be prepared.

A performance standard of known concentration is analyzed during each analytical session. Agreement within $\pm$ 10% of the vendor's published value is required. If such a recovery is not found consult the supervisor

Sample preservation is verified at log-in

Standards and reagents preparation are documented in the benchsheet notebook..

HYDROLOGIC, INC.

Analytical Procedure

Title: Oil and Grease - Hydrocarbon	
Date issued: 10 February 1993	Supercedes:
Issued by:	

Safety:

Lab coat
Safety glasses
Extraction should be carried out under a fume hood to avoid inspiration of vapors.
Freon 113 is flammable and should not be exposed to an ignition source.

Equipment:

1000 ml separatory funnel
250 ml Erlenmeyer flask with 24/40 standard taper
12.5 cm Whatman #40 filter paper
Water bath capable of maintaining 70 ± 1°C
Distilling head
West condenser
1000 ml graduated cylinder
Stir plate with stir bars

Reagents:

Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane)
Silica gel 60 to 200 mesh

Procedure:

Follow "Oil and Grease" Procedure to initially separate Freon soluble oils and greases.
If hydrocarbon oil and grease is to be determined in addition to determining total oil and grease, proceed as follows.

-Extract the sample as described in the Oil & Grease - Total procedure.
-After weighing the evaporated total oil and grease residue, redissolve the extract with 100 ml of Freon. The total oil and grease should contain less than 100 mg of extract.
-Add 3.0 g of silica gel, stopper and stir the mixture for 5 minutes
-Weigh to the nearest 0.1 mg a 250 ml Erlenmeyer flask and record on the benchsheet.
-Filter into a tared Erlenymeyer flask with 24/40 taper through Whatman #40 filter paper to remove silica gel. Rinse the original flask and funnel with 10 ml of freon.
-Distill off the freon at 70° ± 1°C. Record the water bath temperature on the benchsheet.

-Place in a desiccator for a minimum of 30 minutes.
-Weigh to the nearest 0.1 mg the resulting residue and calculate (see Calculation section) the mg/L Hydrocarbon Oil and Grease

If the hydrocarbon oil and grease is to be determined without regard to the total oil and grease concentration proceed as follows:

-Extract the sample as described in the Oil & Grease - Total method and then:
-Add 3.0 g of silica gel to the Freon extract, stopper, and let stir for 5 minutes.
-Weigh to the nearest 0.1 mg a 250 ml Erlenmeyer flask with 24/40 standard taper. Record weight on benchsheet.
-Into a tare 250 ml Erlenmeyer flask with a 24/40 taper filter the mixture through Whatman #40 filter paper. Rinse the original flask and funnel with 10 ml of Freon.
-Distill of the Freon at 70°C ± 1°C. Record water bath temperatue on the benchsheet.
-Reweigh to the nearest 0.1 mg the flask and calculate (see Calculation Section) the mg/L of Hydrocarbon Oil and Grease.

A blank should be run substituting 500 ml of distilled water for the sample. Any residue weight found in the blank must be subtratcted from the sample resiude weight as defined by the calculation.

Calculation:

$$\text{mg/L Hydrocarbon Oil and Grease} = \frac{(D - \text{Blank}) \times 1000}{A}$$

Where: A = Sample volume in liters
B = Final flask weight
C = Initial flask weight
D = B - C

Quality control:

Samples for hydrocarbon oil and grease determination should be preserved by lowering pH to < 2 with H_2SO_4 at the time of collection and cooled to 4°C. All samples must be collected in glass and be at least 850 ml in sample volume. The samples should be analyzed within 28 days of collection.

A blank determination is run with each analytical session.

A performance evaluation is run with each total oil and grease analytical session and carried through to the hydrocarbon oil and grease determination. No hydrocarbon oil and grease should be found.

A blank determination is made with each analytical session and the residue weight in the blank subtracted from the sample residue weight in the calculation.

The balance is calibrated daily and a 100 g Class S weight is weighed before each weighing session dictated by the methodology. The observed weight of the Class S weight is recorded on the benchsheet.

The water bath temperature is verified and recorded on the benchsheet with each analytical session.

Proper preservation is verified at log-in

HYDROLOGIC, INC.

Analytical Procedure

Title: Oil and Grease - Total	
Date issued: 12 February 1993	Supercedes: 30 May 1990
Issued by:	

Safety:

Lab coat
Safety glasses
Extraction should be carried out under a fume hood to avoid inspiration of vapors.
Freon 113 is flammable and should not be exposed to an ignition source.

Equipment:

1000 ml Separatory funned
250 ml Erlenmeyer flasks with 24/40 standard tapers
Whatman #40 filter paper 12.5 cm
Water bath capable of maintaining 70°C ± 1°C
Distilling head
West condenser
Graduated cylinders (various sizes)

Reagents:

Freon 113 (1,1,2-trichloro-1,2,2trifluoroethane)
Sodium sulfate, anhydrous (Na_2SO_4)

Procedure:

Weigh to the nearest 0.1 mg a 250 ml Erlenmeyer flask with 24/40 standard taper. Record the weight on the benchsheet.
Mark the meniscus of the sample in the sample bottle
Transfer the entire contents of the sample to a 1000 ml separatory funnel.
Add 30 ml of Freon 113 to the sample bottle and swirl to remove in sample remaining in the sample container. Transfer the rinse to the separatory funnel containing the sample.
Shake the separatory funnel vigorously for 2 minutes. Allow the aqueous and organic layer to separate.
Drain the freon layer through Whatman #40 filter paper into a tared 250 ml Erlenmeyer flask with 24/40 standard taper. Should an emulsion develop add 1 g of Na_2SO_4 to the funnel in which the filter paper is place. Additional Na_2SO_4 may be added in 1 g aliquotes to insure a dry aliquote is collected.
Shake the sample with 30 ml portions of Freon 113 an additional two times.

Rinse the tip of the separatory funnel and the filter with 10 ml of Freon 113.
Connect the Erlenmeyer flask with standard taper to the West condenser via the distilling head. Submerge the set up in the water bath at 70° ± 1°C . Record water bath temperature on the benchsheet. Distill until all the Freon is out of the Erlenmeyer flask.
Remove from the water bath and disconnect the distillation apparatus. Remove solvent vapors by sweeping the flask with air. Place the flask in a desiccator for a minimum of 30 minutes.
Determine the sample volume by filling the sample container to the mark previously made. Transfer the water to a 1000 ml graduated cylinder and record the volume on the benchsheet in liters.
Reweigh the Erlenmeyer flask to the nearest 0.1 mg and record weight on the benchsheet. Calculate (see Calculations Section) the oil & grease content of the sample and record on the benchsheet. If the oil and grease content is less than 1 mg/L report as <1.0 mg/L.
Determine a blank by following the analytical procedure substituting 500 ml of water for the sample. Any residue weight found in the blank must be subtracted from the sample residue weight as described in the calculation.

Calculation:

$$\text{mg/L oil \& Grease} = \frac{(D - \text{Blank}) \times 1000}{A}$$

Where: A = Sample volume in liters
B = Final flask weight (g)
C = Initial flask weight (g)
D = B -C

Quality Control:

Samples for oil and grease determination should be preserved by adding H_2SO_4 to pH <2 and chilling to 4°C at the time of collection. Oil & Grease samples must be grab samples collected in glass with a volume of no less than 850 ml. The samples must be analyzed within 28 days of collection. (Concentrated HCl may be substituted as preserving acid for H_2SO_4.)

A blank determination using H_2O is run with each analytical session. Any determinable residue weight in the blank is subtracted from the sample residue weight.

A performance standard of known concentration is run with each analytical batch.

The balance is calibrated daily and a 100 g Class S weight weighed to verify calibration. The Class S weight is weighed at the start of each weighing step and the observed value recorded on the benchsheet.

The water bath temperature is verified with each analytical session and documented on the benchsheet.

Proper sample preservation is verified at log-in.

HYDROLOGIC, INC.
Analytical Procedure

Title: pH Determination Aqueous Samples	
Date Issued: 2 Sept. 1994	Supersedes: 7 May 1990
Issued by:	

Safety: Lab coat
Safety glasses

Preservation: Sample should be chilled to 4°C at the time of collection. The samples should be analyzed as soon after collection as practicable.

Reporting limits: There are *per se* no detection limits for pH. Thus, the pH value observed should be reported. The temperature at which the determination is made as well as the temperature of the buffer solutions must be documented on the benchsheet. The temperature of the buffer solutions and samples should be within ± 2°C of each other.

Equipment: pH Meter equipped with a temperature compensation probe, reference electrode, and low sodium error electrode.
Glass beakers (one for each sample and buffer solution)
Stir plate and teflon coated stir bars.

Reagents: Buffer solution pH 4.0
Buffer solution pH 7.0
Buffer solution pH 9.0
Buffer solution pH 12.0
Note all buffer solutions must be traceable to NIST primary standards.

Procedure: Calibration: Select a pair of buffers which will bracket the expected pH of the sample being measured. Complete the standardization procedure for the specific meter available at the Asheville Laboratory as given below.
Fisher 925 MP: Remove the electrodes from the storage buffer, rinse and blot dry. Avoid rubbing the pH electrode tip directly as this will impart a charge to the glass and protract the calibration process. Immerse the electrode in the selected buffer with the lowest pH which is being agitated such that no vortex is formed. Exercise care when immersing the electrodes to avoid striking the electrode with the stir bar.
Depress the "Stby/Meas" key followed by the "Two Point Cal" key. Enter the value of the standard. When the instrument has come to equilibrium as indicated be the display of five (5) stars (*), depress the "Enter" key and record the millivolt reading and the temperature of the buffer solution on

the benchsheet
Remove the electrodes from the buffer, rinse and blot dry.
Immerse the electrode into the higher buffer solution which is being agitated such that no vortex is formed.
Depress the "Stby/Meas" key followed by the value of the buffer. Allow the instrument to come to equilibrium as indicated by the display of five (5) stars (*), depress the "Enter" key and record the millivolt reading and the temperature of the buffer solution on the benchsheet.
Enter the efficiency on the benchsheet.
Orion 720 A: Select the channel which has the pH and reference electrodes installed. This can be accomplished by depressing 2nd/channel until the correct channel is selected. Depress the "Mode" key until the pH mode indicator is displayed.
Depress the "Calibrate" key and after a few seconds enter the number of buffers to be used for the standardization. Typically, this is two (2).
When the "Buffer 1" prompt appears Remove the electrodes from the storage buffer, rinse and blot dry. Avoid rubbing the pH electrode tip directly as this will impart a charge to the glass and protract the calibration process. Immerse the electrode in the selected buffer with the lowest pH which is being agitated such that no vortex is formed. Exercise care when immersing the electrodes to avoid striking the electrode with the stir bar. Allow the instrument to stabilize as indicated by the audible beep and appearance of the "Ready Cal" prompt. Via the numeric key pad enter the value of the buffer and depress the "Yes" key. Depress the "2nd" key and millivolts. Record the value and temperature on the benchsheet.
At the "Buffer 2" prompt immerse the electrodes in the second buffer and wait for the instrument to stabilize as previously described. Enter the value of the second buffer solution and depress yes. Depress the "2nd" key and millivolts. Record the value and temperature on the benchsheet. Also, record the "Slope" of the calibration in the on the bnechsheet.
Sample Determination:
Place an aliquote of sample (approximately 100 ml) into a 150 ml beaker. After beginning agitation which does not produce a vortex immerse the electrodes in the solution.
Observe the stable pH value. Add an additional 25 ml aliquote and again observe the stable pH reading. If the pH values agree within 0.1 pH units record the value and temperature of the sample on the benchsheet. Should the initial and subsequent pH value differ by more than 0.1 pH units continue adding successive aliquotes until agreement within 0.1 pH units is obtained. Record the pH and temperature on the benchsheet.

Calculations:

$$\% \text{ Standard recovery} = \frac{\text{Observed value}}{\text{True Value}} \text{ X } 100$$

$$\text{RPD} = \frac{(|\text{ Repl. 1 -Repl. 2}|)}{((\text{Repl 1} + \text{Repl 2})/2)} \text{ X } 100$$

Quality Control:

Proper sample preservation is verified at log in.
Duplicate samples are analyzed at a minimum rate of 10% The replicates must agree within the upper control limit as define by the precision control chart. Failure to achieve acceptable replication requires that the sample be rerun. Should on the second attempt acceptable replication not be obtained notify the supervisor for assistance in identification and correction of the problem.
Prior to beginning the sample run the calibration must be verified by analyzing a buffer solution with a value covered by the calibration curve. The observed value must recover within the upper and lower control limits of the buffer control chart. Failure to recover within this range requires that the calibration be redone and the verification reattempted. Failure on the second attempt requires notification of the supervisor for identification and remedy of the cause.
Prior to beginning the sample run an independent set point standard must be run. The observed value must recover within the upper and lower control limits of the buffer control chart. Failure to recover within this range requires that the calibration be redone and the verification reattempted. Failure on the second attempt requires notification of the supervisor for identification and remedy of the cause.
Should one (1) hour or more lapse between the initial calibration and sample determination, the integrity of the calibration must be demonstrated by running the verification buffer as described above. Failure to recover within the control limits necessitates recalibration of the instrument.

References:

Clesceri, Lenore S., *et. al.*, *Standard Methods for the Examination of Water and Wastewater, 17th Ed.*, " 4500-H+ B Electrode Method," p 4-95 ff, 1989.

US EPA, *Methods for Chemical Analysis of Water and Wastes,* "Method 150.1 pH Electrometric," 1983.

US EPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW 846, 3rd Ed.*, " Method 9040A pH Electrometric Measurement," 1986.

HYDROLOGIC, INC.

Analytical Procedure

Title: Phenol Determination 4-AAP with Distillation	
Date issued: 17 February 1993	Supercedes:
Issued by:	

Safety:

Lab Coat
Safety glasses
Chloroform is flammable, do not expose to an ignition source
Chloroform extractions should be performed under a fume hood to avoid inhalation of vapors.
Caution should be exercised in handling concentrated ammonium hydroxide, it is extremely corrosive and severe burns can result if contacted with skin.
Preparation of the buffer solution should be carried out under a fume hood to avoid inhalation of ammonia fumes.

Equipment:

Separatory funnels
Graduated cylinders (various sizes)
Pipets (various sizes)
Erlenmeyer flask (500 ml)
pH meter (Standardized according to pH procedure)
Whatman #40 filter paper
Kjeltec 1026 distillation unit with 750 ml distillation tube.
Volumetric flasks (various sizes)

Reagents:

Phenol standard 1000 ppm Ricca Cat. #5740
Intermediate phenol standard 10 ppm *Preparation:* Into a 500 ml volumetric flask pipet 5.0 ml of phenol standard. Dilute to volume with deionized water. Shake to mix. Prepare fresh with each analytical session.
Working phenol standard 1 ppm *Preparation:* Into a 500 ml volumetric flask pipet 50.0 ml of intermediate phenol standard. Dilute to volume with deionized water. Shake to mix. Prepare fresh with each analytical session.
Cupric sulfate ($CuSO_4$) *Preparation:* To the nearest 0.1 g weigh 100 g of $CuSO_4 \cdot 5H_2O$. Quantitatively transfer to a 1000 ml volumetric flask. Add sufficient water to dissolve. When $CuSO_4$ is in solution dilute to volume with deionized water. Shake to mix.
Ferrous Ammonium Sulfate ($Fe(NH_4)_2(SO_4)_2$) *Preparation:* Weight to the nearest 0.1 mg, 1.1 g of $Fe(NH_4)_2(SO_4)_2 \cdot 6H_20$.

Quantitatively transfer to a 1 L volumetric flask containing 500 ml of deionized water and 1 ml of concentrated sulfuric acid. Swirl to mix. When $Fe(NH_4)_2(SO_4)_2$ is dissolved dilute to volume with deionized water. Shake to mix.

Buffer solution *Preparation:* To the nearest 0.1 mg weigh 33.8 g of ammonium chloride (NH_4Cl). Quantitatively transfer to a 500 ml volumetric flask and add 286 ml of concentrated ammonium hydroxide (NH_4OH). Swirl to dissolve NH_4Cl. When dissolved dilute to volume with deionized water. Shake to mix. The pH of this solution at 25°C should be 10. Verify using pH procedure. Additionally, the pH should be verified prior to each analytical session when not prepared fresh. If the pH of the solution is not 10 @ 25°C, reprepare.

Preparation of this solution should be carried out under a fume hood to avoid inhalation of ammonia vapor.

4-aminoantipyrine *Preparation:* To the nearest 0.1 mg weigh 2.0g of 4-aminoantipyrine. Quantitatively transfer to a 100 ml volumetric flask. Add sufficient deionized water to dissolve. Then dilute of volume with deionized water. This solution should be prepared fresh with each analytical session.

Potassium ferricyanide ($K_3Fe(CN)_6$) *Preparation:* To the nearest 0.1 mg weigh 8.0 g of $K_3Fe(CN)_6$. Quantitatively transfer to a 100 ml volumetric flask. Add sufficient to dissolve. Then dilute to volume and mix. This solution should be prepared fresh with each analytical session.

Sodium sulfate anhydrous ($NaSO_4$)

Reference standard of known concentration

Procedure:

Standard curve:

Prepare a standard curve by pipeting 3.0, 5.0, 10,0, 20.0, and 25.0 mls of working standard into individual separatory funnels. Add sufficient water to make the total volume 500 ml. The solutions are respectively 6.0, 10.0, 20.0, 40.0, and 50.0 ug/L in phenol. To each solution add 10 ml of buffer solution and mix. Then add 3 ml of 4-aminoantipyrine and mix. Finally add 3 ml of $K_3Fe(CN)_6$ and mix. Allow the solutions to stand for 3 minutes. After 3 minutes add 25 ml of chloroform and shake a minimum of 10 times. Allow the aqueous and organic layers to separate. Shake the solution again a minimum of 10 times and allow the layers to separate.

Drain the chloroform layer through a Whatman #40 filter paper containing approximately 5 g of $NaSO_4$.

Read the absorbance of each standard solution at 460 nm and record observed absorbance on the benchsheet.
A blank should be carried through the analytical procedure using 500 ml of deionized water. Set the instrument baseline using the blank extract.
Prepare a standard curve plotting standard concentration against absorbance. Archive in benchsheet notebook.
Sample Determination:
Into a 750 ml distillation tube place a 500 ml aliquote or other suitable aliquote of sample add 5 ml of $CuSO_4$ and 5 ml of $Fe(NH_4)_2(SO_4)_2$. Record the sample aliquote on the benchsheet.
Attach the distillation tube to the distillation unit and distill until a volume equal to the sample aliquote is collected.
Transfer the distillate to a separatory funnel. If less than 500 ml of sample is used add sufficient water to bring the volume in the separatory funnel to 500ml.
Add 10 ml of buffer solution and mix. Follow this with 3 ml of 4-aminoantipyrine and mix. Next add 3 ml of $K_3Fe(CN)_6$ and mix. Finally, allow the color to develop for 3 minutes.
After 3 minutes add 25 ml of chloroform and shake the mixture at least 10 times. Allow the layer to separate and repeat the shaking procedure.
Drain the chloroform layer through Whatman #40 filter paper containing approximately 5 g of $NaSO_4$.
Determine the absorbance of the solution at 460 nm and record the value on the benchsheet.
Determine the phenol concentration in the sample by comparing the observed sample absorbance to the standard curve. Record this value on the benchsheet.
Calculate the phenol concentration as outline in the calculation section. Record on benchsheet.

Calculation:

$$\text{ug/L Phenol} = \frac{\text{ug/L phenol from curve x 500}}{\text{Sample vol. (ml)}}$$

Quality control:

Samples requiring phenol analysis must be collected in glass and preserved by lowering the pH to <2 with H_2SO_4 at the time of collection. Phenol samples should be grab samples.

A standard curve must be prepared by each analyst prior to running any samples. Validity of this curve should be verified by the supervisor.

With each analytical session a blank and a 6.0, 10.0, and 50.0 ug/L standard should be determined. The values obtained should be within ±10% of the values predicted by the standard curve. If not, preparation of a new standard curve is indicated.

Duplicate analysis are performed at a rate of not less than 10%.

A performance standard of known concentration is determined with each analytical session. The value found should be within ±10% of the vendor's published value. If not, contact the supervisor for corrective action

Solution and standards preparation are verified in the benchsheet notebook.

Proper sample preservation is verified at log-in.

HYDROLOGIC, INC.

Analytical Procedure

Title: Phosphorus - Ortho	
Date issued: 21 Jan. 1992	Supercedes:
Issued by:	

Safety:

Safety glasses
Lab coat

Equipment:

Beakers (various sizes) precleaned with boiling 1+1 HCl
Pipets (various sizes)
Volumetric flasks (various sizes)
Spectrophotometer
Cuvets

Reagents:

Nanopure water

Sulfuric acid 5N *Preparation:* Fill a 500 ml volumetric flask approximately half full with deionized water. Slowly add 70 ml of concentrated sulfuric acid (H_2SO_4). Allow to cool to room temperature. Dilute to volume with deionized water.

Ascorbic acid solution *Preparation:* To the nearest 0.1mg weigh 1.76g of ascorbic acid. Quantitatively transfer to a 100 ml volumetric flask and dilute to volume with deionized water. This solution is prepared fresh with each analytical session.

Antimony potassium tartrate solution *Preparation:* Weigh 1.3715 g of antimony potassium tartrate hemihydrate and quantitatively transfer to a 500 ml volumetric flask. Add enough water to dissolve. Then dilute to volume with deionized water. Store refrigerated in a dark bottle.

Ammonium molybdate solution *Preparation:* Weigh to the nearest 0.1 mg 20.0 g of ammonium molybdate tetrahydrate and quantitatively transfer to a 500 ml volumetric flask. Swirl to dissolve and dilute to volume. Store at 4°C in the flask in which the reagent is prepared..

Combined reagent Preparation: In exactly the order given mix the following: 50 ml of 5N H_2SO_4, 5 ml of antimony potassium tartrate solution, 15 ml of ammonium molybdate solution and 30 ml of ascorbic acid solution. Swirl after the addition of each reagent. The resulting solution must be turbidity free before proceeding. Should any of the reagents be turbid prior to use discard the solution and prepare a fresh solution.

Phosphate standard 50 ppm PO_4 Ricca Cat. # 5830
Intermediate phosphate standard *Preparation:* Pipet 5 ml of phosphate standard into a 500 ml volumetric flask and dilute to volume. Mix well. The intermediate standard is 0.5 ppm PO_4.
Performance sample of known concentration

Procedure:

Standard Curve
Into 50 ml volumetric flask serially dilute the intermediate PO_4 standard to produce a set of working standards which are 0.01, 0.03, 0.05, 0.10, 0.20, 0.30, 0.40, and 0.50 ppm PO_4 respectively. Transfer each to a beaker. Prepare a blank by placing 50 ml of deionized water in a beaker.
To each standard add 8 ml of combined reagent and swirl to mix. Allow the color to develop for 10 minutes
Measure the absorbance of each standard a 880 nm and record on the benchsheet. Use the balnk to set the baseline. Prepare a standard curve by plotting concentration PO_4 (mg/l) against concentration.
Sample determination
Pipet 50.0 ml of sample or an aliquote diluted to 50 ml into a 150 ml beaker. Record sample volume on benchsheet.
Add 8 ml of combined reagent and allow the color to develop for 10 minutes.
Within 30 minutes determine the absorbance of sample at 880 nm and record on benchsheet.
Determine the concentration of total phosphorus in the sample by comparing the sample absorbance to the standard curve. Record the value on the benchsheet. Calculate ppm total phosphorus in the sample and record on the benchsheet.

Calculation:

$$\text{mg/L total phosphorus} = \frac{\text{mg/L found} \times 100}{\text{Sample aliquote}}$$

Quality Control:

Samples for ortho phoshphorus analysis should be filtered on-site and cooled to 4°C. The analysis must be performed within 48 hours of collection.

Duplicate analysis are performed at a rate of not less than 10%

For each analytical session a 0.01, 0.10, and 0.50 mg/L ppm PO_4 standard must be run. The values obtained must be within ±15% of the value expected from the standard curve. Failure of this criterion indicates the necessity of a new standard curve.

A standard curve must be prepared and documented in the benchsheet notebook by each analyst prior to performing any total phosphorus analysis. The curve must be updated at least one time per quarter. Upon updating the new curve must produce values within ±15% of the value expected when compared to the previous curve.

A performance standard of known concentration is analyzed during each analytical session. The value obtained must be within ±20% of the vendor's published value.

Sample preservation is verified at log-in.

Standards and reagent preparation is documented in the benchsheet notebook.

HYDROLOGIC, INC.

Analytical Procedure

Title: Total Phosphorus	
Date issued: 9 Sept. 1993	Supercedes: 20 Jan. 1992
Issued by:	

Safety:

Safety glasses
Lab coat

Equipment:

Autoclave capable of maintaining 121°C @ 15-20 psig for 30 min.
125 ml Erlenmeyer flask precleaned with boiling 1+1 HCl
Beakers (various sizes) precleaned with boiling 1+1 HCl
Pipets (various sizes)
Volumetric flasks (various sizes)
Spectrophotometer
Cuvets

Reagents:

Nanopure water

Sulfuric acid 11N *Preparation:* To 600 ml of deionized water slowly add 310 ml of concentrated sulfuric acid (H_2SO_4). Exercise care in preparation of this reagent, the heat of solution is extremely exothermic and the possibility of thermal and chemical burns is great.

Ammonium Persulfate

Sulfuric acid 5N *Preparation:* Fill a 500 ml volumetric flask approximately half full with deionized water. Slowly add 70 ml of concentrated sulfuric acid (H_2SO_4). Allow to cool to room temperature. Dilute to volume with deionized water.

Ascorbic acid solution *Preparation:* To the nearest 0.1mg weigh 1.76g of ascorbic acid. Quantitatively transfer to a 100 ml volumetric flask and dilute to volume with deionized water. This solution is prepared fresh with each analytical session.

Antimony potassium tartrate solution *Preparation:* Weigh 1.3715 g of antimony potassium tartrate hemihydrate and quantitatively transfer to a 500 ml volumetric flask. Add enough water to dissolve. Then dilute to volume with deionized water. Store refrigerated in a dark bottle.

Ammonium molybdate solution *Preparation:* Weigh to the nearest 0.1 mg 20.0 g of ammonium molybdate tetrahydrate and quantitatively transfer to a 500 ml volumetric flask. Swirl to dissolve and dilute to volume. Store at 4°C in the flask in which the reagent is prepared..

Combined reagent Preparation: In exactly the order given mix the following: 50 ml of 5N H_2SO_4, 5 ml of antimony potassium tartrate solution, 15 ml of ammonium molybdate solution and 30 ml of ascorbic acid solution. Swirl after the addition of each reagent. The resulting solution must be turbidity free before proceeding. Should any of the reagents be turbid prior to use discard the solution and prepare a fresh solution.
Phosphate standard 50 ppm PO_4 Ricca Cat. # 5830
Intermediate phosphate standard *Preparation:* Pipet 20 ml of phosphate standard into a 500 ml volumetric flask and dilute to volume. Mix well. The intermediate standard is 2.0 ppm PO_4.
Performance sample of known concentration

Procedure:

Standard Curve
Into 50 ml volumetric flask serially dilute the intermediate PO_4 standard to produce a set of working standards which are 0.04, 0.12, 0.20, 0.40, 0.80, 1.20, 1.60, and 2.00 ppm PO_4 respectively. Transfer each to a beaker. Prepare a blank by placing 50 ml of deionized water in a beaker.
To each standard and blank add 1.0 ml of 11 N H_2SO_4 and 0.4 g of ammonium persulfate.
Place in an autoclave and heat for 30 min at 121°C and 15-20 psig. Note that heating does not begin until the temperature and pressure requirements are met. Thus, the total time in the autoclave will be about 30 minutes longer.
After heating let the standards and blank cool to room temperature. Pipet 25 ml of each solution into a 100 ml volumetric flask and dilute to volume. The standards concentrations will be 0.01, 0.03, 0.05, 0.10, 0.20, 0.30, 0.40, and 0.50 ppm respectively.
To each standard and blank add 8 ml of combined reagent and swirl to mix.
Allow the color to develop for 10 minutes
Measure the absorbance of each standard a 880 nm and record on the benchsheet. Use the blank to set the baseline. Prepare a standard curve by plotting concentration PO_4 (mg/l) against concentration.
Sample determination
Pipet into a 125 ml Erlenmeyer flask 50.0 ml of sample.
Add 1.0 ml of 11N H_2SO_4 and 0.4g of ammonium persulfate.
Place in an autoclave and heat for 30 min at 121°C and 15-20 psig. Note that heating does not begin until the temperature and pressure

requirements are met. Thus, total time in the autoclave will be longer than 30 minutes.
After heating, depressurize the autoclave slowly, remove samples and let cool to room temperature.
Transfer the sample or an aliquote of the sample to a 100 ml volumetric flask and dilute to volume with deionized water. Shake the flask to mix contents. Record the sample volume on the benchsheet.
Transfer the sample to a 150 ml beaker and add 8 ml of combined reagent.
Allow the color to develop for ten minutes.
Within 30 minutes determine the absorbance of sample at 880 nm and record on benchsheet.
Determine the concentration of total phosphorus in the sample by comparing the sample absorbance to the standard curve. Record the value on the benchsheet. Calculate ppm total phosphorus in the sample and record on the benchsheet.

Calculation:

$$\text{mg/L total phosphorus} = \frac{\text{mg/L found} \times 100}{\text{Sample aliquote}}$$

Quality Control:

Samples for total phosphorus should be preserved with the addition of H_2SO_4 to pH <2 and chilling to 4°C at the time of collection. The analysis must be performed within 28 days of the time of collection.
Duplicate analysis are performed at a rate of not less than 10%. Duplicates should agree within the upper confidence limit established by the precision control chart.
Sample spikes are performed at a rate of not less than 10%. Spike recovery should be within 15% of the expected value.
For each analytical session a 0.01, 0.10, and 0.50 mg/L ppm PO_4 standard must be run. The values obtained must be within $\pm$10% of the value expected from the standard curve. Failure of this criterion indicates the necessity of a new standard curve.
A standard curve must be prepared and documented in the benchsheet notebook by each analyst prior to performing any total phosphorus analysis. The curve must be updated at least one time per quarter. Upon updating the new curve must produce values within $\pm$10% of the value expected when compared to the previous curve.

A performance standard of known concentration is analyzed during each analytical session. The value obtained must be within ±12% of the vendor's published value.
Sample preservation is verified at log-in.
Standards and reagent preparation is documented in the benchsheet notebook.

Quality Control:

Samples requiring sulfate analysis should be preserved by cooling to 4°C at the time of collection. The sample must be analyzed within 28 days of collection.

A standard curve must be prepared by each analyst prior to performing any analysis. The curve must be updated at least one time per quarter. Upon updating the curve the value produced by the new standards should be within ±10% of the expected values predicted by the previous curve.

Duplicate analysis are performed at a rate of not less than 10%.

For each analytical session the 1.0, 5.0, and 10.0 ppm $SO_4^=$ standards must be run. The values found when compared to the curve should be within ±15% of the expected concentration. Failure to produce this recovery indicates the need for a new curve.

A performance standard of known concentration must be run during each analytical session. The value obtained must be within ±15% of the vendor's published value. If not, contact the supervisor.

Meter standardization is repeated after each sample determination.

Solution preparation is documented in the benchsheet notebook.

Proper sample preservation is verified at log in.

HYDROLOGIC, INC.

Analytical Procedure

Title	Sulfide Determination - Titrametric
Date issued: 5 February 1993	Supercedes:
Issued	

Safety:

Lab Coat
Safety glasses

Equipment:

Volumetric flask (various sizes)
Pipets (various sizes)
Buret (50 ml)
Stir plate with stir bars
Erlenmeyer flasks (500 ml)

Reagents:

6 N HCl *Preparation:* Into a 500 ml volumetric flask which is partially filled with water, slowly add 250 ml of concentrated HCl. Swirl to mix, let cool, and dilute to volume with deionized water. Exercise caution the heat of solution is markedly exothermic and burns could result.
Starch indicator *Preparation:* See B. O. D. procedure
0.025 N Iodine solution Ricca Cat. #3975
0.025 N Sodium thiosulfate (NaS_2O_3) Reagents Cat. #7-32805

Procedure:

To a 500 ml Erlenmeyer flask pipet 20 ml of 0.025 N Iodine.
Record volume of iodine added on the benchsheet.
Add 2 ml of 6N HCl.
With the pipet tip below the liquid surface in the Erlenmeyer flask pipet 200 ml of sample. Record sample volume.
If the iodine color disappears add an additional 20 ml of 0.025 N Iodine. Record the volume of additional Iodine required on the benchsheet. Continue to add 0.025 N Iodine until the color persists.
Add starch indicator.
Titrate with 0.025 N NaS_2O_3 until the blue starch color is discharged. Record the volume on the benchsheet.
Calculate the sulfide concentration (see Calculation section) and record on the benchsheet.

Calculation:

$$\text{mg/L sulfide} = \frac{400(A - B)}{\text{Sample vol(ml)}}$$

A = Volume of 0.025 N Iodine (ml)
B = Volume of 0.025 N NaS_2O_3

Quality Control:

Sample requiring sulfide determination should be cooled to 4°C at the time of collection. Two ml of $Zn(Ac)_2$ should also be added and the pH raised to pH >9 with NaOH at the time of collection.
Duplicate analysis are performed at the rate of not less than 10%
All solution preparation is documented in the benchsheet notebook.
Sample preservation is verified at log-in.

HYDROLOGIC, INC.

Analytical Procedure

Title: Sub-contracted analysis	
Date issued 7 Jan 1992	Supercedes
Issued by	

Safety: Safety glasses and lab coat

Equipment: Chain of custody

Procedure: All subcontracted analysis should be shipped within 24 hours of receipt.
Toxicity samples are the exception in that they must be shipped immediately and by a carrier which will insure that the sample arrives at the laboratory performing the analysis within 24 hours of sampling
Complete the normal log-in process as described in "Log-in Procedure."
Split samples according to the minimum volumes as stipulated in the "Sample Preservation Procedure."
Verify that the split samples are properly preserved.
Label each bottle with the appropriate sample label as generated by Labtrol.
Complete chain-of-custody for the samples being subcontracted.
Complete subcontracted analysis shipping log. Use one log sheet per day.
Typical subcontracted analysis are summarized in the chart below

Parameter	Matrix	Subcontract lab
All organic analysis	All types	HydroLogic Frankfort, KY
Toxicities	All types	HydroLogic Morrisville
Arsenic	Drinking water	Oxford
Barium	Drinking water	Oxford
Selenium	Drinking water	Oxford
Arsenic	Waste water/soil	HydroLogic Morrisville
Selenium	Waste water/soil	HydroLogic Morrisville
Beryllium	All types	HydroLogic Morrisville
Tin	All types	Oxford
Mercury	Minette Mills	Oxford
Antimony	All types	Oxford
VOC	Drinking water	Webb Tech
COD	All types	HydroLogic Lumberton
MLVSS	Waste water	HydroLogic Lumberton
Volatile suspended solid	All types	HydroLogic Lumberton
TCLP	All types	HydroLogic Morrisville
Fluroide	Waste water	Oxford

WASTEWATER SERVICES, INC.

Analytical Procedure

Title: Sample Preservation

Issue date: 21 Jan. 1990

Approved by:

Safety precautions: Eye, skin protection required

Purpose: Although degradation of a sample cannot be altogether eliminated, the effects of such degradation can be retarded. Thus, sample preservation is designed to retain the integrity of the sample.

Reagents: Hydrochloric acid (HCl)
Nitric acid (HNO_3)
Sulfuric acid (H_2SO_4)
Sodium hydroxide (NaOH)
Zinc acetate ($Zn(Ac)_2$)
Ascorbic acid

Equipment: Dropping pipets
Scoopula
pH paper (pHydrion papers range pH 1 to 12)
Stirring rods

Procedure: For those samples requiring a pH adjustment to achieve proper preservation proceed as follows:
-Select the appropriate pH adjusting reagent as given in Table 1.
-Remove approximately 3 cm of pHydrion paper from the dispenser. By means of a wash bottle moisten the pH paper.
-Immerse a clean stirring rod in the sample and agitate the sample.
-Remove the stirring rod from the sample and touch the end of the stirring rod to the pHydrion pH paper. Match the color of the paper to the approximate pH of the sample.
-Carefully add the appropriate pH adjusting reagent (see Table 1) to the sample. Take care not to grossly overshot the desired pH, but use sufficient reagent to achieve the desired pH. The pH of the sample should be frequently checked by moistening a 3 cm strip of pHydrion pH paper, immersing a clean stir rod in the sample, stirring, and touching the end of the stir rod to the paper.
Those samples requiring a preservation technique other than simple pH adjustment should be preserved according to the instructions given in Table 1

TABLE 1

Parameter	Container	Volume required	Preservation method
Color	P,G	50 ml	Cool to 4°C
Conductance	P,G	100 ml	Cool to 4°C
Hardness	P,G	100 ml	HNO_3 to pH <2
Odor	G	200 ml	None required
Residue			
Filterable	P,G	100 ml	Cool to 4°C
Non-filterable	P,G	100 ml	Cool to 4°C
Total	P,G	100 ml	Cool to 4°C
Volatile	P,G	100 ml	Cool to 4°C
Setteable	P,G	1000 ml	Cool to 4°C
Metals	P,G	200 ml	HNO_3 to pH <2
Chromium +6	P,G	200 ml	Cool to 4°C
Acidity	P,G	100 ml	Cool to 4°C
Alkalinity	P,G	100 ml	Cool to 4°C
Chloride	P,G	100 ml	None required
Cyanides	P,G	500 ml	NaOH to pH >12 0.6g ascorbic acid
Fluoride	P,G	300 ml	None required
Nitrogen			
Ammonia	P,G	400 ml	H_2SO_4 to pH <2
TKN	P,G	500 ml	H_2SO_4 to pH <2
Nitrate/ Nitrite	P,G	100 ml	H_2SO_4 to pH <2
Nitrate	P,G	100 ml	Cool to 4°C
Nitrite	P,G	100 ml	Cool to 4°C
Phosphorus			
Ortho	P,G	50 ml	Cool to 4°C
Total	P,G	100 ml	H_2SO_4 to pH <2
Sulfate	P,G	50 ml	Cool to 4°C
Sulfide	P,G	500 ml	2 ml $Zn(Ac)_2$ Plus NaOH to pH >9

TABLE 1
(cont.)

Parameter	Container	Volume Required	Preservation method
BOD	P,G	1000 ml	Cool to 4°C
COD	P,G	100 ml	H_2SO_4 to pH <2 Cool to 4°C
Oil & Grease	G	1000 ml	H_2SO_4 to pH <2
Phenolics	G	500 ml	H_2SO_4 to pH <2
MBAS	P,G	250 ml	Cool to 4°C

HYDROLOGIC, INC.

Analytical Procedure

Title: Settleable Matter	
Date issued 21 Oct 1991	Supercedes:
Issued by	

Safety Precautions: Safety glases and lab. coat

Equipment: Imhoff cone and rack

Procedure: Transfer 1L of well agitated sample to Imhoff cone.
Let sample stand in rack for 1 hour.
Observe volume of samples settled in the bottom of the cone after 1 hour.
Record this volume as settleable in ml/L/hr.

HYDROLOGIC, INC.

Analytical Procedure

Title: Specific Conductance	
Date Issued: 7 Sept 1994	Supersedes:
Issued by:	

Safety: Lab coat
Safety Glasses

Preservation: Sample should be chilled to 4°C at the time of collection. The samples should be analyzed as soon after collection as practicable.

Reporting limits: There are *per se* no detection limits for specific conductance. The specific conductance measurement should be made at 25°C. If the temperature is not 25°C a temperature correct should be made and the value obtained reported. (See Calculation Section)

Equipment: Conductivity Meter equipped with conductivity cell
Thermometer capable of being read to the nearest 0.1°C.

Reagents: Water with conductivity of less than 1umho/cm (18 megaohm)
Potassium chloride (KCl) anhydrous
Standard KCl solution (0.0100 N): Prepare by weighing to the nearest 0.1 mg 0.7456 g of KCl which has been previous dried for 3 hours at 105°C. Quantitatively transfer to a 1000 ml volumetric flask. Add sufficient water to fully dissolve KCl. Swirl to affect dissolving. Dilute to volume with water. The specific conductance of this solution is 1413 umho/cm at 25°C.

Procedure: Determination of cell constant:
Rinse the conductivity cell with three aliquotes of standard KCl solution. Immerse the conductivity cell in a fourth aliquote of standard KCl and record conductivity and temperature of the solution. The temperature of this solution should be as near 25°C as possible.
Calculate the cell constant as given in the calculation section. Record on the benchsheet..
Sample Determination:
Rinse the conductivity cell with several aliquotes of sample
Adjust the temperature of the final aliquote to 25°C and record the specific conductance and temperature on the benchsheet. It is important to make

the determination as near 25°C as possible. As the temperature deviates from 25°C the less uncertain the temperature correction becomes.
If the temperature is not 25°C apply the temperature correction calculation as given in the calculation section.

Calculations:

Cell Constant:

$$C = (0/.001413)(R_{KCl}) + 0.0191(t-25)$$

Where:

R_{KCl} is the measured resistance in ohms
t is the observed temperature

Temperature correction:

$$K = \frac{(K_m)(C)}{1 + 0.0191\ (t - 25)}$$

Where:

K = Conductivity in umho/cm
C = Cell constant
K_m = measured conductivity in umho/cm at the observed temperature
t = the observed temperature

Relative percent difference (RPD):

$$RPD = \frac{|(\text{Repl. 1} - \text{Repl. 2})|}{((\text{Repl. 1} + \text{Repl. 2})/2)} \times 100$$

Standard recovery:

$$\%\ \text{Recovery} = \frac{\text{Found value}}{\text{True value}} \times 100$$

Quality Control:

Proper sample preservation is verified at log in.
Duplicate samples are run at a minimum rate of 10%. Duplicates should agree within the UCL of the Precision control chart or less than 20% RPD which ever is lower. Failure to meet these criteria requires that the sample be rerun. With a second failure notify the supervisor for assistance in identification and correction of the problem.

A standard of known specific conductance is run with each analytical batch. The found value must the within the upper and lower control limit defined by the control chart or ±10% of the true value, which ever is lowest. Failure to achieve results within these criterion necessitates notification of the supervisor for assistance in identification and correction of the problem.

The specific conductance of the standard KCl solution is determined with each analytical batch. The observed specific conductance, corrected for temperature, must be within ± 5% of 1413 or within the limits established by the control chart. Failure to produce a recovery within these criteria requires that the standard be reprepared and rerun. A second failure necessitates contacting the supervisor for identification and correction of the problem.

References:

USEPA, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, SW 846,* "Method 9050 Specific Conductance," 1986.

USEPA, *Methods for Chemical Analysis of Water and Wastes,* "Method 120.1 Conductance," 1983.

HYDROLOGIC, INC.

Analytical Procedure

Title: Sulfate Determination	
Date Issued: 29 Jan. 1993	Supercedes:
Issued by:	

Safety:

Safety glasses
Lab Coat

Equipment:

Volumetric pipets (various sizes)
Mohr pipets (various sizes)
Volumetric flasks (various sizes)
Stir plate and stir bars
Stop watch
Turbidimeter Hach 2100A
Filtering flasks
Whatman Type A/E glass fiber filters
Gelman filter apparatus

Reagents:

Nanopure water or equivalent
Sulfate standard (100 ppm $SO_4^=$) Ricca Cat. #8110
Barium chloride crystals ($BaCl_2$) Reagents Cat. #1-14700
Conditioning reagent Ricca Cat. # 2235
Turbidity standard 10 NTU
Performance standard of known concentration

Procedure:

Standard curve:
Prepare a standard curve by serially diluting the 100 ppm sulfate standard such that working standards which are 1.0, 2.0, 5.0, 8.0, and 10.0 ppm in sulfate are produced. Note to prepare the 8.0 ppm working standard prepare an intermediate standard by pipeting 20.0 ml of 100 ppm stock solution to a 50 ml volumetric flask and dilute to volume. From this well mixed intermediate standard pipet 20.0 ml of intermediate standard to a 100 ml volumetric flask. Dilute to volume. This standard is 8.0 ppm in $SO_4^=$.
Standardize the turbidimeter using a 10 NTU standard.
Transfer the standards to a 250 ml beaker. While vigorously agitating the sample add 5 ml of conditioning reagent and a mid-size scoop of $BaCl_2$. ($BaCl_2$ should be in excess to insure complete reaction with the $SO_4^=$ present.)
Allow the mixture to continue to stir for exactly 1 minute after the $BaCl_2$ addition.

Immediately transfer to a clean, dry turbidity cuvet. Place the cuvet in the turbidimeter and measure the turbidity at half minute increments for 4 minutes. The highest turbidity reading observed is taken as the turbidity of the standard.
Plot the $SO_4^=$ concentration against turbidity in NTU's to form the standard curve.
Sample determination:
Filter 300 ml of sample through Whatman Type A/E glass fiber filters to remove interfering turbidity.
Transfer 100 ml of sample, or an aliquote of sample diluted to 100 ml to a 250 ml beaker. Record on the benchsheet. With vigorous agitation add 5 ml of conditioning reagent and a mid size scoop of $BaCl_2$ crystals. (Sufficient $BaCl_2$ should be added to insure complete reaction with $SO_4^=$ present in the sample.)
Immediately transfer an aliquote of sample to a clean, dry turbidity cuvet. Record the turbidity of the sample in half minute increments for four minutes. The highest turbidity observed should be recorded as the turbidity of the sample.
Determine the $SO_4^=$ content of the sample by comparing the observed turbidity against the standard curve. Record the concentration found. Calculate $SO_4^=$ concentration and record on the benchsheet. (See calculation section)

Calculation:

$$\text{mg/L } SO_4^= = \frac{\text{mg/L } SO_4^= \text{ found} \times 100}{\text{Sample aliquote (ml)}}$$

HYDROLOGIC, INC.

Analytical Procedure

Title: Total Dissolved Residue	
Date issued: 21 Oct 1991	Supercedes:
Issued by:	

Safety Precautions: Lab coat and safety glasses required
Use caution handling evaporating dishes after drying, they are hot and can cause severe burns.

Equipment: Evaporating dishes
100 ml Graduated cylinders
Drying oven capable of maintaining 103-105oC
Drying oven capable of maintaining 178-182oC
Analytical balance
Crucible tongs
Dessicator
Membrane filter funnel
Suction flask
Aspiration source
Crucible holder
Crucibles
Whatman 934 AH microfibre filters of equivalent

Procedure: Crucibles, evaporating dishes, and filtering apparatus should be thoroughly cleaned with laboratory soap and water.
Shake sample to insure a homogeneous sample is obtained.
Filter a minimum of 200 ml of sample through crucible with microfibre filter
Weigh an evaporating dish which has been previously dried by placing in an oven at 104oC for a minimum of 2 hours, to the nearest 0.1 mg. Record weight as initial weight (W1)
By means of a graduated cylinder transfer 100 ml SAMPLE TO EVAPORATING DISH

HYDROLOGIC, INC
Analytical Procedure

Title: Total Dissolved Solids	Pg 3 of 3

Accuracy of the balance is verified by weighing a Class S weight at the beginning of each weighing step. The observed weight of the Class S weight is recorded on the benchsheet. A distilled water blank is run with each batch of analysis to insure that the water is free of total residue. Blank values are subtracted from the W1 - W2 weight difference.

HYDROLOGIC, INC.

Analytical Procedure

Title: Total Kjedhal Nitrogen (TKN)	
Date Issued: 26 January 1993	Supercedes:
Issued by:	

Safety:

Lab Coat
Safety glasses
Fume hood

Equipment:

Vacuum source
Tekator 1026 Distillation Unit
Tekator 1007 Block Digestor
Digestion tubes (100 ml) with boiling rods
Pipets various sizes
Beakers various sizes
Buret 50 ml

Reagents:

Digestion Reagent Ricca Cat.# 2550-1
Sodium hydroxide 40% with 2.5% sodium thiosulfate
Ricca Cat.# 7490-2.5
0.1N Sulfuric Acid (H_2SO_4) Reagents Cat.# 7-30550
0.02N Sulfuric acid (H_2SO_4) *Preparation:* Transferring 100 ml to a 500 ml volumetric flask. Dilute to volume with deionized water.
Boric acid 2% *Preparation:* Weight to the nearest 0.1g 40 g of boric acid. Quantitatively transfer to a 2000 ml volumetric flask. Add enough water to dissolve. Then dilute to volume.
Mixed indicator: *Preparation* Weigh into a 100 ml volumetric flask 0.20 g of methyl red. Dilute to volume with ethanol and mix to dissolve. In another 100 ml volumetric flask weight 0.20 g of methylene blue indicator. Dilute to volume with ethanol and mix to dissolve. To prepare the indicator mix two part of the methyl red indicator and 1 part methylene blue. This indicator should be prepared fresh with each analytical session.
0.02N Sodium carbonate reagent (Na_2CO_3) *Preparation:* Dry a quantity of Na_2CO_3 at 110°C for three hours. Weigh to the nearest 0.1 mg 1.060 g of dried Na_2CO_3. Quantitatively transfer to a 1000 ml volumetric flask. Add sufficient water to dissolve. Then dilute to volume with water.
TKN standard Preparation: Wiegh to the nearest 0.1 mg 2.1006 g of L (+) glutamic acid. Quantitatively transfer to a 2000 ml

volumetric flask. Add 2 ml of concentrated H_2SO_4. Add enough water to dissolve. Dilute to volume with distilled water. Dilute this solution ten times to prepare the 10 PPM TKN working standard.

Procedure:

Transfer 100 ml of sample or an aliquote diluted to 100 ml to a digestion tube. Record sample volume on benchsheet.

Add 20 ml of digestion reagent. Place 2 boiling rods in each tube such that the concave end of the rod in down.

Assemble the digestion apparatus. To capture the SO_2 fumes evolved place the aspiration discharge line under water. Exercise care not to turn the aspiration on too strongly, otherwise sample may be aspirated once boiling begins.

Heat the tubes at 385°F until the generation of SO_2 fumes is minimal.

Disassemble the digestion apparatus. After a 5 minute cooling period remove the boiling rods. This should be done before the sample residue solidifies.

To a 250 ml beaker add 25 ml of 2% boric acid solution.

Place the digestion tube in the distillation unit. Verify unit settings as: 2 Alkali pump strokes, 2 count delay, and 4 minute distillation. Initialize distillation by depressing "Auto/Man" button. The distillate should be collect below the level of the boric acid.

Disassemble the distillation apparatus and titrate with 0.02 N H_2SO_4 to the purple mixed indicator end point. Record volume of 0.02N H_2SO_4 on the benchsheet.

A blank consisting of 100 ml of water should be carried through the analytical process. The volume of 0.02N H_2SO_4 required to titrate it to the proper endpoint should be noted on the benchsheet.

Calculate TKN concentration in the sample. Record on benchsheet.

<u>Standardization:</u>

Pipet 25 ml of 0.02N Na_2CO_3 in to a 250 ml beaker. Record volume on benchsheet.

Titrate with 0.02N H_2SO_4 to the purple mixed indicator record the volume required on the benchsheet. (See calculation section for calculation.)

Calculation:

$$N\ H_2SO_4 = \frac{(N\ Na_2CO_3) \times (Vol\ Na_2CO_3)}{Vol\ of\ H_2SO_4}$$

$$mg/L\ TKN = \frac{(ml\ H2SO4 - blank)(N\ H_2SO_4)(14,000)}{Sample\ aliquote}$$

Quality Control:

Sample should be preserved by chilling to 4°C and adding H_2SO_4 to pH < 2 at the time of collection.
A blank is run with each analytical session and the volume of H_2SO_4 required to titrate it subtracted from the volume of H_2SO_4 required to titrate each sample.
A 10 ppm TKN standard is run with each analytical session. The value found must be within ± 10% of the anticipated value.
A performance standard of known concentration is run with each analytical session. The value obtained must be within ±15% of the vendor's published value.
The 0.02N H_2SO_4 is standardized during each analytical session.
Proper sample preservation is verified at log-in.
All solution preparation and standardizations are documented in the benchsheet notebook.

HYDROLOGIC, INC.

Analytical Procedure

Title: Total Nitrogen	
Date issued: 26 Jan. 1993	Supercedes:
Issued by:	

Equipment: Calculator

Reagents: None required

Procedure: Total nitrogen is a calculation combining the results of the TKN, $N(NO_3)$, and $N(NO_2)$ determinations. All data are reported in mg/L.

Calculation: Total Nitrogen = mg/l TKN + mg/l $N(NO_3)$ + mg/l $N(NO_2)$

Quality Control: As required by the individual procedures.

HYDROLOGIC, INC.

Analytical Procedure

Title: Total suspended solids	
Date issued 27 February 1992	Supercedes: 10/21/91
Issued by:	

Equipment:

Aluminum Foil Weighing Dishes
100 ml Graduated cylinder
Drying oven (capable of maintaining 103-105°C)
Gelman glass fiber filters Type A/E 47 mm
Gelman filtering apparatus
Filtering flasks
Dessicator
Analytical balance
Crucible tongs
Vacuum source

Procedure:

Weigh each filter to the nearest 0.1 mg and record as initial weight.
Place filter in prenumbered aluminum weighing dish.
Shake samples to insure homogeneity
Transfer 100 ml of sample or an aliquot diluted to 100 ml to the graduated cylinder. Record sample volume used.
Place filter corresponding to the sample being determined in the filter apparatus and begin aspiration.
Pour sample through filtering apparatus.
Rinse graduated cylinder with a minimum of 10 ml of water.
Disassemble filter apparatus and return filter to the orginal numbered weigh dish.
Place the aluminum weighing dish, and filter, in the drying oven at 104°C for 1 (one) hour.
(Begin timing after the oven returns to 104°C.)
At the end of 1 (one) hour, place the filters along with the aluminum weighing dishes in the dessicator to cool to room temperature. (Minimum 30 minutes)
Weigh dried filter to the nearest 0.1 mg and record weight as final weight.
Care should be taken determining the initial and final weights that the balance is stable.

HYDROLOGIC, INC.

Analytical Procedure

Title: **Toxicity Characteristic Leaching Procedure (TCLP)**	
Date Issued: 6 September 1993	Supercedes:
Issued by:	

Safety:

Lab coat
Safety glasses
Gloves
All sample manipulations should be carried out under a fume hood as practicable.

Equipment:

Balance capable of weighing 0.01g
Magnetic stir plate and stir bars
Hot plate
Pressure filtration system
Rotary agitator capable of maintaining 30 ± 2 rpm for 18 ± 2 hrs.
Glass fiber filters 0.6 to 0.8 um
pH meter Standardized according to "pH Procedure"
Extraction jars
Sieve 9.5 mm
400 ml Griffin beakers
1000 ml graduated cylinder

Reagents:

1.0 N HCl Ricca Cat. #3700
1.0 N NaOH Ricca Cat. #7450
Glacial Acetic acid Reagents Cat. #5-10060
Extraction Fluid #1 Ricca Cat. #8377
Extraction Fluid #2 Ricca Cat. #8378

Procedure:

This procedure applies only to metals determinations. For those samples which contain no significant amount of solids (<0.5% dry solids), the liquid after filtration through 0.6 to 0.8 um glass fiber filter paper is considered the TCLP extract. This extract should be acidified to pH < 2 with HNO3 immediately and digested according to the procedure "Digestion- Total Metals in aqueous matrices." Those waste containing a significant amount of solids (>0.5% dry solids) should be carried through the following procedure.

Preliminary Evaluations:

Determination of Percent Solids

If the waste will obviously yield no liquid when subjected to pressure filtration proceed to the Extraction step. However, if the sample is liquid, multiphasic or a liquid solid mixture weigh to the nearest 0.01g a 100 g subsample of the waste. Record the weigh on the benchsheet.

Allow the subsample phases to separate

Weigh to the nearest 0.01g the filter and record the weight on the benchsheet.

Also weigh to the nearest 0.01g the weight of the vessel which will receive the filtrate.

Assemble the filtration apparatus according to the manufacturer's instructions.

Quantitatively transfer the subsample to the filter holder (all phases) taking care to insure that the subsample is evenly distributed over the surface of the filter. Observe if the subsample is obviously adhering to the surfaces of the vessel used to transfer to subsample. If it is determine the residue is left in the vessel and subtract that amount from the initial sample weight. If the subsample did not adhere to the vessel surfaces proceed without making this weight adjustment.

Gradually apply pressure to the filtration apparatus. Care should be exercised to avoid applying sudden high pressure to the system. Sudden high pressure applications can damage the glass fiber filters requiring that the subsample be discarded and the procedure be started over.

Gently add pressure from 1 to 10 psi until air moves through the filter. If after 2 minutes no additional liquid passes and the pressurizing air does not pass through the filter increase the pressure by 10 psi. Continue this process to a maximum of 50 psi. The material remaining in the filter holder is the solid phase of the sample. In certain wastes, most notably oily wastes and paint wastes, there will usually be some liquid remaining in the filter holder after the pressurization. This remaining liquid is part of the solid phase and should not be removed.

Determine the weights of the filtrate and the solid phase. (See calculations section.)

If it is observed that a small amount of liquid is entrained on the filter, dry the filter and solid phase at 100o to 120oC until two successive weighings agree within 1%. Substitute the dry solid phase weight in the percent solids calculation.

Determination of Particle Size Reduction

Using a portion of the solid phase, determine if the solids will pass through a 9.5 mm sieve. Record result on the benchsheet.

Determination of Extraction Fluid

Weigh to the nearest 0.01g a 5g subsample into a 400 ml beaker. Add 96.5 ml of Nanopure water.

Cover the mixture and vigorously agitate for 5 minutes. Determine the pH of the mixture and record on the benchsheet.

If the pH is >5.0 add 3.5 ml of 1.0N HCl. Heat the mixture to 50°C for 10 minutes. Let cool to room temperature and determine the pH again. Record the value on the benchsheet.

Extraction

Prior to beginning the actual extraction evaluate the results of the Preliminary Evaluations based on the following criteria.

1. Will the sample obviously yield no liquid when subjected to pressure filtration? If so, proceed with the extraction after carrying out the necessary size reduction and extraction fluid determination.
2. Are the percent solids ≥0.5%? If so, proceed with the extraction using the solid phase, after carrying out the necessary size reduction and extraction fluid determination. The result liquid phase will be recombined with the TCLP extract at the end of the procedure.
3. Did the sample contain no solids? If so, the filtrate is considered the TCLP extract. This extract should be appropriately preserved and digested as prescribed in the "Digestion-Total Metals in Aqueous Matrices," procedure.
4. Was there a filtrate produced as a result of the pressure filtration? If so, store at 4°C. This filtrate will be combined with the liquid fraction resulting from the TCLP extraction of the solid phase. The resulting liquid will become the TCLP extract. Should the two liquids be incompatible, that is form layers or form a precipitate up recombination, they will be analyzed separately and the results combined mathematically.
5. Was particle size reduction necessary? If so, reduce the particle size of the solid phase and proceed with the extraction using the appropriate extraction fluid.
6. What was the initial pH of the sample? Was it <5.0? If so, use Extraction fluid #1 (pH 4.93) and proceed with the extraction after completing all other preliminary evaluations.
7. Was the pH >5.0 initially? What was the pH after the addition of 1.0N HCl? If the second pH was <5.0 use extraction fluid #1 (pH 4.93). If the second was still > 5.0 use Extraction fluid #2 (pH 2.88).

When the Preliminary Evaluations are complete quantitatively transfer the solid phase to the extraction vessel. Record the weight of solid phase used on the benchsheet. Determine the amount of extraction fluid required and record on the benchsheet. (See Calculation Section)

Slowly add the proper extraction fluid. Tightly close the extraction vessel. By means of the rotary tumbler, tumble the mixture for 18 ±2 hrs. at 30 ± 2 rpm. Record the beginning and ending times on the benchsheet.
Some wastes may produce a gas as the extraction proceeds. Any excess pressure may be vented, under a hood, at 15 minute intervals as required.
At the conclusion of the extraction period, turn the agitator off and separate the solid and liquid phases by filtering through acid washed 0.6 to 0.8 um glass fiber filter paper. Determine the pH of the liquid phase and record on the benchsheet.
If there was no initial liquid phase in the waste then the filtered liquid is the TCLP extract. Otherwise, the filtered liquid phase should be recombined with the filtrate as outlined above.

Calculations:

Determination of Percent Solids:

$$\% \text{ Solids} = \frac{(\text{Weight of solid + filter}) - (\text{Weight of filter})}{(\text{Weight of waste + vessel}) - (\text{Weight of vessel})} \times 100$$

Determination of Weight of Extraction Fluid:

$$\text{Weight of extraction} = \frac{20 \times \%\text{Solids} \times \text{Weight of waste}}{100}$$

Quality Control: TCLP extraction should be carried out as soon as practicable after collection. No preservatives should be added prior to TCLP extraction. If refrigeration to 4°C does not adversely affect the sample the samples may be cooled to 4°C. Should precipitation occur on refrigeration this should be avoided.
Sufficient quantity of sample should be collected to allow completion of the Preliminary Evaluations.
TCLP extracts should be preserved to pH < 2 with HNO_3 if doing so does not produce precipitation. If precipitation occurs the extraction must be repeated, eliminating the final acid preservation.
Duplicate extractions should be carried out at a rate of not less than 10%.

KENTUCKY LABORATORY

QUALITY ASSURANCE / QUALITY CONTROL MANUAL

for
Hydrologic, Inc.
1491 Twilight Trail
Frankfort, Kentucky 40601
(502) 223-0251

Prepared by
Hydrologic, Inc.
1491 Twilight Trail
Frankfort, Kentucky 40601
(502) 223-0251

[Laboratory Director] [Date] 8/11/94

[QA/QC Officer] [Date] 8/11/94

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QUALITY ASSURANCE/QUALITY CONTROL
STATEMENT OF COMMITMENT

The purpose of this document is to detail the Quality Control/Quality Assurance program of the laboratory. The program is designed to meet the requirements of modern Good Laboratory Practices (GLP).

This program is followed to insure that our clients receive analytical data meeting their requirements for precision, accuracy, completeness, and legal and scientific validity.

Various employees of the lab have differing responsibilities in the implementation of this plan, but the primary responsibility for setting company policy and committing company funds is vested with the Lab Director. The Quality Assurance Officer in coordination with the Lab Director is responsible for the commitment to and approval for the Quality Control Program.

This lab has adopted this Quality Control Plan to establish and maintain the quality and performance of analytical services for all clients.

Frankfort-Hydrologic
Melissa J. Russell
QA/QC Officer

1.0 INTRODUCTION

This lab is committed to producing high quality analytical data from the analysis of environmental samples. We have developed this QA/QC Plan to ensure that standardized protocols are followed and documented for each sample analyzed.

Several tasks must be accomplished using this program.

1. Samples must be representative of sampled conditions.
2. Proper analytical procedures must be followed.
3. Analytical equipment must be in good working order.
4. Raw data must be reduced to usable client formats.
5. All above items must be well documented.

With these goals in mind, this lab has developed a comprehensive QA/QC Program that is documented in this manual and in various standard operating procedures (SOP) manuals. The key elements of this program are detailed in Figure 1. A combination of elements is used to satisfy the requirements of a specific analysis and/or project.

2.0 LAB ORGANIZATION/PERSONNEL

Lab staff is designed to allow individuals to specialize in key areas of responsibility. An Organizational Chart of the lab is shown in Figure 2. An Hydrologic Corporate organizational chart is shown in Figure 3. Given the current small size of the lab, duties will be assigned as necessary to cover these areas of responsibility.

Brief descriptions of responsibilities for the individuals involved in lab management and operation are listed below:

1. Laboratory Manager-serves as daily operations and technical manager, responsible for final review of data and reports, responsible for coordination of all lab projects.

2. QA/QC Officer-serves as an advisor of all QA/QC aspects, administrator of quality control procedures and techniques, responsible for evaluating data quality and maintaining records of QC charts and quality assurance programs, reviews performance evaluation results.

3. Project Manager-responsible for client liaison activities and coordination of lab projects with the Lab Manager, advisor of waste management and chemical hygiene/safety programs.

4. Section Supervisors-responsible for daily technical operation of their related department, responsible for review of analytical data for clarity and validity, responsible for verifying that QC and analytical procedures are being followed as specified

in this manual and Standard Operating Procedures, advise Laboratory Manager of progress, needs and potential problems in their department.

3. Sample Custodians-responsible for completing and filing all documents pertinent to the analyses of each set of samples, responsible for issuing designated serialized documents and accountability for said documents.

4. Analysts-perform analytical procedures, data manipulations, and recording per established Standard Operating Procedures including calibration and preventive maintenance of instrumentation, responsible for reporting out-of-control situations to their supervisors.

HYDROLOGIC-FRANKFORT STAFF

1491 Twilight Trail ☐ Frankfort, KY 40601 ☐ 502/223-0251 ☐ FAX 502/875-8016 ☐ Toll Free 1-800/729-2251

Name: **Benjamin Carl Esterle**
Position: Laboratory Director

Education: B.S Chemistry University of Louisville 1984
Minor Math

Brief Description: The Laboratory Director serves as the Senior Scientist/Consultant on all aspects of technical lab operations, both to clients and to lab personnel. The Laboratory Director retains responsibility for the efficient execution and overall performance of the laboratory. Mr. Esterle has been HydroLogic-Frankfort's Laboratory Director since July 1993. Before becoming Laboratory Director, he served as a GC/MS chemist at HydroLogic after eight years of environmental experience gathered throughout the United States.

Name: **Melissa J. Russell**
Position: QA/QC Coordinator

Education: M.Eng. Chemical Engineering,
University of Louisville, 1988
B.S. Applied Science and Mathematics,
University of Louisville, 1987

Brief Description: The QA/QC Officer is responsible for execution of performance according to the Quality Assurance/Quality Control Manual and Standard Operating Procedures. The QA/QC Officer review all reports prior to release to a client for proper QA/QC performance. The QA/QC Officer is also responsible for all communications with state certification offices.

Name: **Jamie Fore**
Position: Project Management

Education: One Year at Kentucky State

Brief Description: The Project Manager manages all aspects of an environmental project including technical consulting, defining test, and furnishing sample kits/containers, directing shipping and receipt schedule of samples, monitoring project timelines, and insuring appropriate deliverables (data) in client-specified formats.

Name: **Billie Wakefield**
Position: Sample Custodian

Education: One Year at Kentucky State

Brief Description: The Sample Custodian receives all samples, checks for any discrepancies between the chain of custody and the samples received, and logs the samples into the system for analysis. The sample custodian may contact the client to confirm the proper analysis for each sample. The sample custodian is also responsible for shipping supplies to clients.

Chemist: Each chemist is responsible for a particular set of analysis. They are as follows:

Name: **Inna Rasputnis**
Position: Organics Supervisor

Education: Ph.D. Chemistry, Leningrad University, 1971
Analysis responsibility: GC/MS Volatile

Name: **Jackie Tinnell**
Position: Organic Chemist

Education: B.S Chemistry/Forensic Science,
Eastern Kentucky University, 1991
Analysis responsibility: GC/MS Semi-Volatile

Name: **Kimberly Martin**
Position: Organic Chemist

Education: B.S. Biology, Georgetown College, 1991
Analysis responsibility: Diesel range Organics/Pesticides/
Herbicides/PCBs

Name: **Greg Talbert**
Position: Organic Chemist

Education: B.S. Chemistry/Forensic Science,
Eastern Kentucky University, 1991
Analysis responsibility: GC Volatiles

Name: **Eric Kopp**
Position: Organic Chemist

Education: B.S. Biology, Purdue University, 1992
Analysis responsibility: Gasoline Range Organics/ GC Volatile

The extraction department members are as follows:

Name: **Alexander Rasputnis**
Position: Extraction Technician

Education: B.S. Civil Engineering, Leningrad University, 1978

Name: **Chris Sanders**
Position: Extraction Technician

Education: One year at ICS Penn State

Name: **Jake Maynard**
Position: Extraction Technician

Education: One semester at University of Kentucky

Name: **Phillip Hall**
Position: Extraction Technician

Education: Western Hills High School

Name: **Nancy Furnish**
Position: Office Manager

Education: B.S. Accounting, Kentucky State University, 1975

Brief Description: The Office Manager is responsible for all financial activities of the specific laboratory including all invoicing to clientele.

Name: **Nathalie Johnson**
Position: General Office

Education: B.T.S. Tourism, Tour Operator Travel Agent, 1991

Name: **Position not filed at this time**
Position: Data Entry

Education:

Statement of Qualifications 1994

HYDROLOGIC
2000

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Asheville, NC A-1
HydroLogic Lumberton Laboratory
Lumberton, NC A-2

HydroLogic Raleigh Laboratory
Raleigh, NC A-2
HydroLogic Salisbury Laboratory
Salisbury, NC A-3
HydroLogic Columbia Laboratory
Columbia, SC A-3
HydroLogic Frankfort Laboratory
Frankfort, KY A-4
HydroLogic Denver Laboratory
Denver, CO A-4
HydroLogic Brentwood Laboratory
Brentwood, TN (Nashville) A-5
HydroLogic Naples Laboratory
Naples, FL A-6
HydroLogic Macon Laboratory
Macon, GA A-6

HydroLogic's Corporate Mission

For our clients, it is our commitment:

- To provide courteous, responsive and personalized service.
- To provide high quality, legally defensible data - ultimately converting clients to advocates.
- To provide advice and solutions capable of meeting our clients' challenges.
- To perform our services in a timely and efficient manner - providing our clients with the required data on the due date.
- To treat all clients with respect, remembering they are the reason we are here.

For our employees, it is our responsibility:

- To provide a motivating and gratifying work environment enabling our employees to realize their full potential.
- To maintain a climate of trust and integrity in relationships inside and outside the corporation.
- To support our communities with cooperative and responsible corporate citizenship.
- To help our people share in the company's success, which they make possible.

For our shareholders, it is our promise:

- To ensure a competitive rate of return on their long-term investment.
- To continuously strengthen existing client relationships while aggressively pursuing new business.
- To anticipate the changes in our industry, giving ourselves and our clients a competitive edge.

Introduction

HydroLogic Laboratories, Inc., is a dynamic and rapidly growing analytical chemistry laboratory network system. This system currently features eleven testing facilities that are located throughout the United States. HydroLogic offers a full range of environmental organic/inorganic analyses and aquatic toxicity testing. With over sixty years of experience, HydroLogic has established a national reputation for delivering accurate, timely and cost effective data.

HydroLogic provides testing for commercial and government clients including water and wastewater treatment facilities; utilities; landfills; hazardous waste management companies; engineering, geo-technical and legal firms; electronics, manufacturing, textile, paper, metal finishing, brewing and agricultural industries.

Benefits of the HydroLogic Network

The many benefits to using HydroLogic's laboratory network are summarized as follows:

- By offering a broad base of experience and a variety of analytical services throughout the network, HydroLogic alleviates the difficulty in searching for multiple laboratories to complete a client's project.

- By maintaining comprehensive quality assurance/quality control (QA/QC) programs, HydroLogic is able to provide high quality services throughout the network system. As a result, the client can depend on HydroLogic's quality regardless of the laboratory selected to perform the analysis.

♦ Several of the individual laboratories offer complementary services to ensure that, when necessary, overflow work can be quickly shuttled to another location where qualified professionals are available to perform the analyses within the required turnaround time.

Analytical Services

The objective of HydroLogic Laboratories, Inc., is to provide quality analytical work at a reasonable cost in the format and time frame required by the clients. HydroLogic provides both routine and specialized analyses including:

- ♦ Aquatic toxicity testing
- ♦ Polychlorinated biphenyl (PCB), volatile, semi-volatile, pesticides (organophosphorus, carbamates, triazine, chlorinated), herbicide, trace metal, hydrazines and nutrient analyses
- ♦ Waste characterization and method development

HydroLogic's Laboratories

Currently, there are ten laboratories in the network strategically located in the eastern, midwestern and western regions of the United States. All laboratories are equipped with sophisticated instrumentation to provide quality analytical services locally, regionally and nationwide. The laboratories are located in:

Asheville, NC	Columbia, SC
Lumberton, NC	Frankfort, KY
Raleigh, NC	Denver, CO
Salisbury, NC	Naples, FL
Brentwood, TN	Macon, GA

Nationwide Locations

HydroLogic Asheville Lab
122 Lyman St
Asheville, NC 28801
CONTACT: Melissa Shook
704-254-5169 / FAX: 704-252-9711
800-231-8889

HydroLogic Frankfort Lab
1491 Twilight Trail
Frankfort, KY 40604
CONTACT: Billie Jo Wakefield
502-223-0251 / FAX: 502-875-8016
800-728-2251

HydroLogic Salisbury Lab
P O Box 1389
122 Mahaley Avenue
Salisbury, NC 28145
CONTACT: Eric Bolin
704-633-8089 / FAX: 704-633-6359

HydroLogic Lumberton Lab
2003 North Pine Street, Suite 2
Lumberton, NC 28358
CONTACT: Pamela Hester
910-738-6190 / FAX: 910-671-8837

HydroLogic Raleigh Lab
2500 Gateway Centre Blvd., Suite 900
Morrisville, NC 27560
CONTACT: Pomeroy Smith, II
919-380-9699 / FAX: 919-380-9717
800-241-4174

Aquatic Toxicity Lab
Raleigh NC
CONTACT: Linda McKenzie
800-241-4174

HydroLogic Columbia Lab
100 Ashland Park Lane, Suite E
Columbia, SC 29210
CONTACT: Shari Baker
803-750-0913 / FAX: 803-750-9505
800-243-0913

HydroLogic Naples Lab
2082 Trade Center Way, #303
Naples, FL 33942
CONTACT: Laura Eldridge
813-597-6059 / FAX: 813-597-7056
800-331-5340

HydroLogic Laboratories, Inc., Brighton, CO
695 N. 7th Avenue
Brighton, CO 80601
CONTACT: Bob Hart
303-659-0497 / FAX: 303-659-5064

HydroLogic Brentwood Lab
201 Summit View Drive
Brentwood, TN 37024
CONTACT: Teresa McClanahan
615-377-8780 / FAX: 615-377-8799

HydroLogic Macon Lab
4875 Riverside Dr.
Macon, GA 31210-1117
CONTACT: Vernice Thomas
912-757-0811 / FAX: 912-757-0149

HydroLogic, Inc. Corporate Headquaters
14 S. Pack Square, Suite 500
Asheville, NC 28801
CONTACT: Alan Kerschen, Dinah Trammel
704-258-3746 / FAX: 704-258-3973
800-344-5759

Future Considerations

HydroLogic Laboratories, Inc., constantly evaluates the ever changing environmental market. As analytical needs change, HydroLogic is committed to providing services that will keep pace with new regulations and new client requirements.

As HydroLogic continues to expand its laboratory locations, facilities will be selected with particular attention to quality, convenience and efficient operations.

What's Covered In This Document

The information presented in this document describes the various components of the HydroLogic network of laboratories. This information should give the reader a thorough understanding of how the components fit together to form HydroLogic's quality-based organization that is committed to providing the client the best possible service:

Chapter 1, Introduction, gives an overview of HydroLogic Laboratories, Inc., by describing the benefits of using the laboratory network, discussing the laboratory locations, listing HydroLogic's analytical services, and taking a look at future considerations at HydroLogic.

Chapter 2, Professional Services, presents the diverse capabilities of HydroLogic's network system, provides a complete list of HydroLogic's analytical services, furnishes details concerning specific regulatory packages used in sample analyses, and describes the "value added" services that HydroLogic offers to its clients.

Chapter 3, Personnel, Instruments and Facilities, describes the laboratory personnel, provides information about HydroLogic's instruments and equipment, describes HydroLogic's facilities and outlines the profiles of HydroLogic's key personnel.

Chapter 4, The HydroLogic QA/QC Summary, discusses organizational responsibility for the QA/QC program, describes the procedures HydroLogic uses to produce quality data, and tracks a sample through the HydroLogic system, from the time it arrives at a HydroLogic laboratory through completion of the analysis.

Chapter 5, Certifications and Accreditation, outlines the state certifications and accreditation held by HydroLogic.

Chapter 6, Project Experience, illustrates the experience that HydroLogic has in performing analyses for commercial and government clients.

Appendix A, HydroLogic Laboratory Backgrounds, gives a brief history of each HydroLogic location.

Professional Services

In the environmental industry, there are a variety of methods, analytical services, and data packages from which to choose. HydroLogic's unique network approach to analytical services makes the decision simple. This network system offers clients the flexibility and responsiveness of a local laboratory while providing the extensive resources of a large laboratory.

HydroLogic's laboratories perform high-quality analyses that meet the criteria of regulatory requirements. In addition, HydroLogic is able to handle large projects, method development and project management. These functions are routinely offered throughout the laboratory network.

This chapter presents the following information:

- The diverse capabilities of the HydroLogic network
- A complete list of HydroLogic's analytical services and details concerning specific regulatory packages
- The "value added" services HydroLogic offers

Laboratory Capabilities

HydroLogic's laboratories have the ability to offer a full range of analytical services to clients who must comply with regulatory requirements. The majority of methodologies used in our environmental analyses meet the requirements of the Code of Federal Regulations (CFR), SW846 (8000 series), and the EPA's 100 through 600 series of organic/inorganic methods for drinking water and wastewater. HydroLogic also has biomonitoring capabilities.

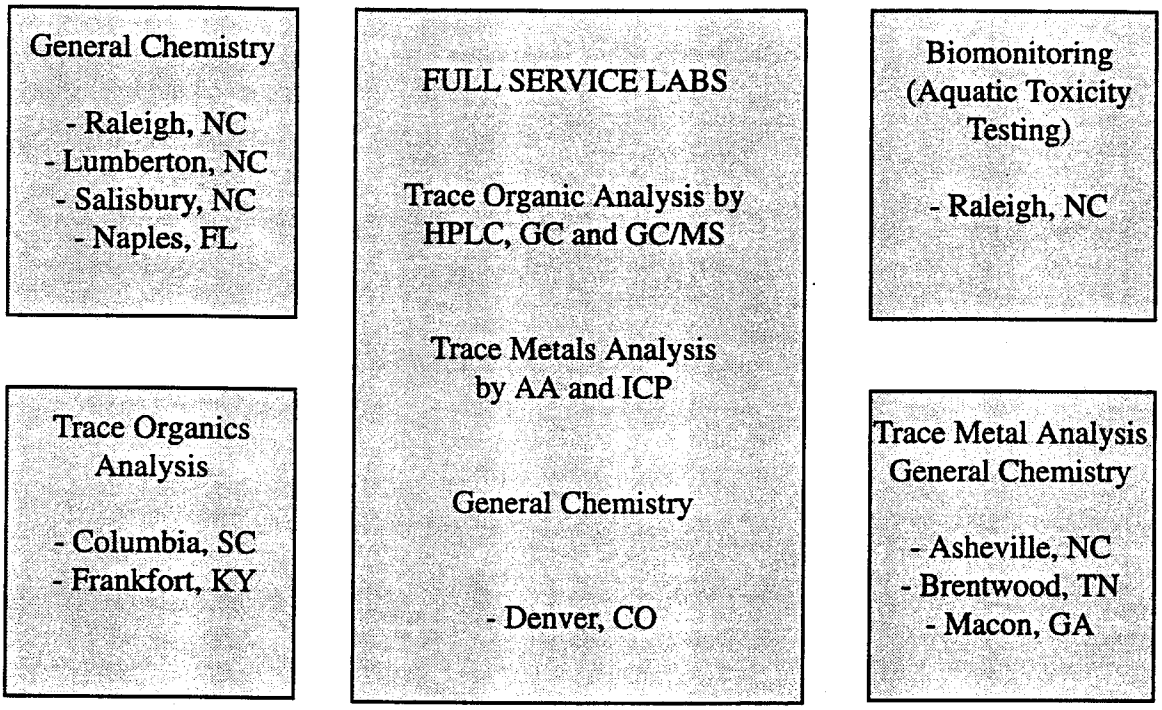
Scope of Services

The following is a summary of the analyses that are performed at HydroLogic Laboratories, Inc.:

Packages	Analyses
(RCRA) Resource Conservation and Recovery Act	Ignitability, corrosivity, reactivity, TCLP, Appendix IX, ground water quality, drinking water suitability, underground storage tanks (USTs), Hazardous Substances List, waste characterizations
(CERCLA/SARA) Comprehensive Environmental Response, Compensation and Liability Act	CLP Target Compound List (TCL) for organics, CLP Target Analyte List (TAL) for inorganics, CLP deliverables
(SDWA) Safe Drinking Water Act	Volatiles, semi-volatiles, pesticides, herbicides, trihalomethanes, primary and secondary drinking water parameters
(CWA) Clean Water Act	NPDES monitoring, priority pollutants, biomonitoring, storm water analysis
(FIFRA) Federal Insecticide, Fungicide, and Rodenticide Act	Pesticides/herbicides analysis, biomonitoring for acute toxicity
(FDA) Food and Drug Administration	Aquatic biomonitoring for acute/chronic toxicity
(TSCA) Toxic Substances Control Act	PCBs, biomonitoring for acute/chronic toxicity
(NPDES) National Pollutant Discharge Elimination System	Biomonitoring (routine and non-routine) - Toxicity Identification Evaluation (Phase I & II) - Toxicity Reduction Evaluation (Phase I & II)
	Classical Chemistry
	Trace Metals Analyses
	Water Quality Testing

Illustration of Services Within the Network

The following illustration shows the diversity of HydroLogic's capabilities throughout the network laboratory system.



"Value Added" Services

In addition to satisfying regulatory, analytical and data management requirements, "value added" services are provided to all clients.

Sampling Container Kits

Sample containers are provided to the client free of charge for non-priority delivery. The client is responsible for shipping costs associated with overnight emergency deliveries, and for transporting filled sample bottles to HydroLogic for testing.

A typical sampling kit may include:

- Sample bottles cleaned according to the required EPA certification level and procedure
- Preservatives already added to the bottles (Preservatives may be sent separately when a client wishes to do preservation in the field.)
- Bottle labels
- Return shipping labels
- Chain of custody forms
- Custody seals
- Coolers and ice packs, as appropriate

Data Management

HydroLogic's data management system is designed to ensure confidentiality and supplies a quick retrieval method for checking the status of a sample. The system uses both electronic media and hard-copy records to ensure the safety and integrity of the data.

Samples are tracked, scheduled, and reported utilizing HydroLogic's information management systems. These resources are periodically updated to accommodate the ever changing analytical requirements of the industry.

Data Reporting

To meet the needs of clients, HydroLogic offers a variety of data package formats. Four standard data packages are available that vary in the degree of supporting data supplied to the client. The most sophisticated data package provides standard CLP deliverable forms. Upon request, computer diskette deliverables and customized reports are available for an additional fee.

Client Service

HydroLogic is committed to providing excellent client service and support. Each HydroLogic laboratory assigns a project manager or a member of the lab management staff to serve as the primary client contact for a given project. These individuals are responsible for tracking the status of the project and ensuring that it is completed according to the client's specifications.

Each laboratory maintains a staff of qualified personnel who are available to provide pricing and methodology information as needed. These professionals can quickly answer any client's questions by accessing HydroLogic's network of professional experts.

Turnaround Time

HydroLogic Laboratories, Inc., recognizes the critical importance of timely completion of the clients' analytical projects. Turnaround time at HydroLogic begins when a sample is received and accepted and ends when a report is issued (including a data package, if requested by the client.) Delivery of information by telefax or verbal communication is available for clients requiring immediate analytical results.

Rush services are available for those instances when a client needs quick turnaround times. All projects are tracked through the lab with constant attention to the required due date.

Field Services

HydroLogic provides its clients with a full range of in-field services. HydroLogic's OSHA-trained sampling teams are equipped with state-of-the-art sampling equipment and are capable of sampling monitoring wells, sanitary and storm sewers, lakes and streams, as well as a wide variety of industrial monitoring settings. Automated equipment is available for time or flow weighted composite sampling.

Sample Return

HydroLogic limits the client's exposure to liability by returning any remaining samples to the client 30 days after completion of the requested analyses.

Personnel, Instruments, & Facilities

HydroLogic Laboratories, Inc., maintains strict standards of quality by selecting exceptional personnel, high-caliber instrumentation and conveniently located laboratory facilities.

HydroLogic's carefully selected team of professionals ensures that clients receive scientific expertise and outstanding client service. Instrumentation is selected to provide the optimum combination of high-quality data and economical operations. The HydroLogic facilities provide direct access to clients throughout the United States.

This chapter presents the following information:

- A summary of HydroLogic's personnel
- HydroLogic's organization chart
- Information about HydroLogic's instruments and equipment
- A brief description of the laboratory facilities
- The profiles of HydroLogic's key personnel

Personnel

HydroLogic's laboratory personnel are highly qualified professionals dedicated to providing quality, value and service for a full scope of analytical services. The members of each laboratory staff meet or exceed the standard in the environmental laboratory industry. For their professional development, HydroLogic continually trains all laboratory personnel in QA/QC, analytical methodologies and new technologies. Continuing education and cross-training are strongly encouraged at all levels of the organization.

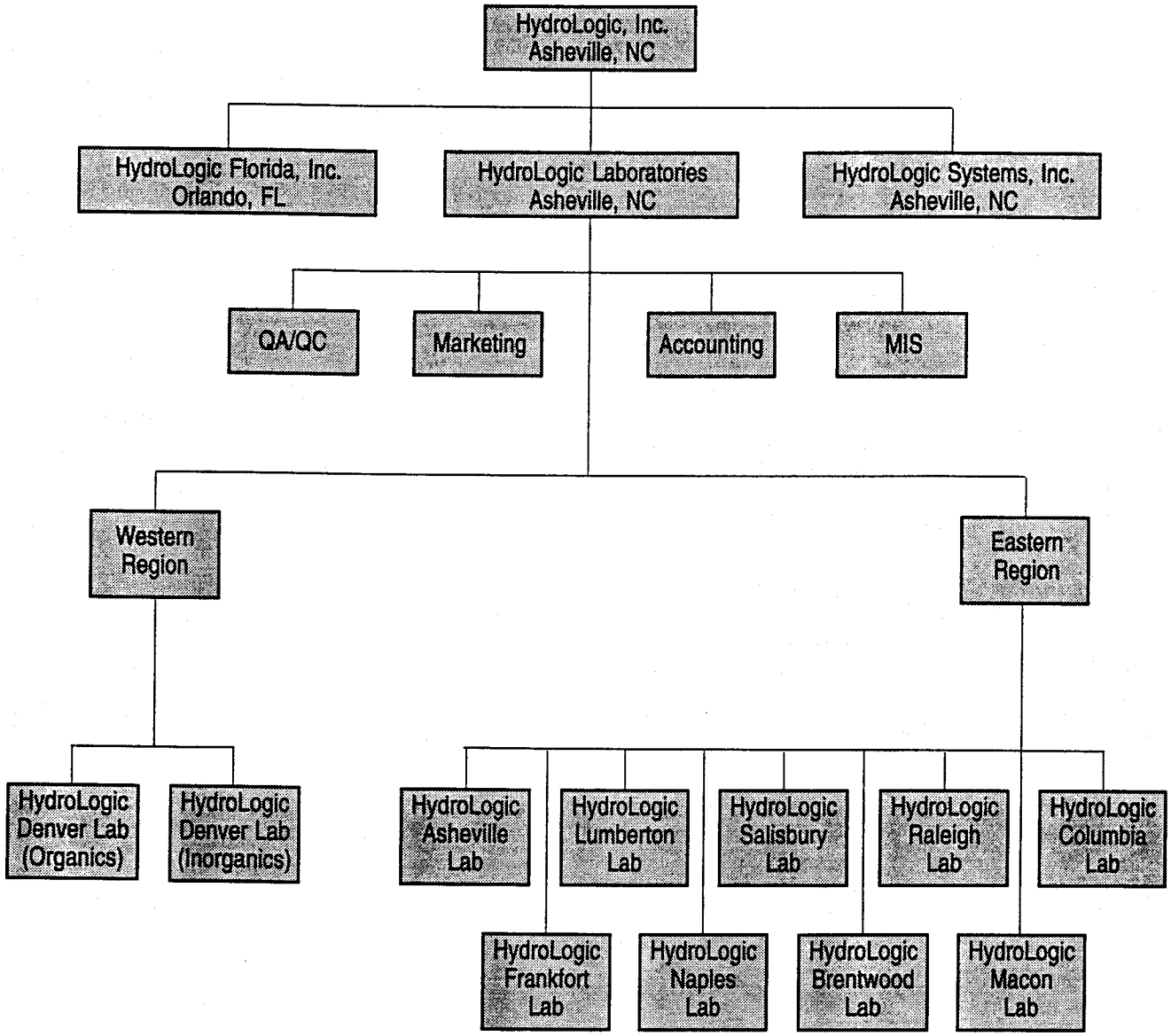
Personnel Summary

The following is a summary of HydroLogic's personnel presented by functional classification.

Funtional Category	Total Number of Employees	Percentage of Total (%)
Senior Chemist	11	12
Senior Biologist	2	2
Chemist	23	26
Biologist	6	7
Technician	26	29
Client Support	13	14
Administration	9	10
TOTAL	90	100

The HydroLogic Organization

The following organization chart outlines the HydroLogic network.



Instrumentation

Instrumentation includes gas chromatographs with a wide range of detectors, gas chromatography/mass spectroscopy, for the determination of trace organic parameters, and high performance liquid chromatography. Inductively coupled plasma and atomic absorption spectroscopy instruments provide trace metal analysis. HydroLogic also has a wide range of instrumentation for classical chemistry and general chemistry parameters.

HydroLogic's instrumentation receives continual preventative maintenance to ensure that they are capable of meeting the stringent requirements of this industry. Whenever possible, automation is utilized to reduce operating costs, and provide cost efficient analyses and high-quality data.

Maintenance and repair of the instrumentation are completed by in-house staff as well as by authorized service personnel from instrument distributors. For critical pieces of equipment, service contracts are maintained to ensure instrument reliability.

Instrument Summary

The following is a summary of the instrumentation utilized throughout the HydroLogic network.

Instrument Type	No. of Instruments
Gas Chromatograph	30
Gas Chromatograph/Mass Spectometer	15
High Performance Liquid Chromatograph	2
Inductively Coupled Plasma Spectrophotometer	4
Atomic Absorption Spectrophotometer	7
TOC Carbon Analyzer	4
TOX Analyzer	3
Gel Permeation Chromatograph	2
UV/VIS Spectrophotometer	8
Infrared Spectrophotometer	3
TCLP Extractor	40
Zero Headspace Extractor	16
Ion Chromatograph	2
Incubator	15
Wastewater Samplers	26
Automatic Titration System	4
Autoclave	7
Environmental Chamber	1
Auto Analyzer	4

Facilities

All locations have been designed to optimize the use of space and create an efficient environment for the performance of analyses, data management, sample receiving and tracking, and safety. Each laboratory is also designed with features allowing flexibility to meet the demands of the environmental testing market.

These features include:

- Refrigerated sample storage
- Adequate sample preparation areas
- Well-designed ventilation systems to minimize contamination
- Adequate Hood Space
- Separate instrumentation areas

Safety

To provide a safe working environment for all HydroLogic personnel, each laboratory has established a safety program that is administered by both laboratory and management personnel. HydroLogic maintains its excellent safety record and adheres to all federal and state laws concerning hazardous waste disposal of samples and extracts.

Profiles of Key Personnel

The following are profiles of selected key personnel at HydroLogic Laboratories, Inc.

Kirby Oblachinski
Vice President of Sales and Marketing, HydroLogic, Inc.

Kirby Oblachinski is responsible for managing, coordinating and directing all sales and marketing activities in the company. He has over twenty years of sales and marketing experience and has focused on managing environmental sales activities

for major environmental firms over the past several years. He has established client based customer service programs for environmental labs and assists HydroLogic in developing and coordinating our customer service program.

Alan Kerschen
Director of Inorganic Laboratories

Mr. Kerschen reports directly to the President and CEO of HydroLogic, Inc. He is responsible for the company's seven inorganic laboratories, special projects and assists in corporate customer service. He has over twenty years environmental laboratory experience, including twelve years of laboratory management. He possesses a broad range of experience including technical expertise, customer service, sales and marketing, and management.

Benjamin Carl Esterle
General Manager, Frankfort, KY Laboratory

Ben Esterle coordinates and directs laboratory operations at the Frankfort facility and is in charge of GC, GC/MS and organic sample preparation. His experience includes: 9 years as an analytical chemist with extensive GC/MS experience; and specialized GC/MS course work throughout his career.

Pamela S. Hester
General Manager, Lumberton, NC Laboratory

Pam Hester coordinates and directs the laboratory at the Lumberton facility. She is North Carolina Grade IV Wastewater Certified and North Carolina Grade B Water Certified. Pam's experience includes extensive treatment plant operations and

lab supervision for a major municipal wastewater/water laboratory. This provided her with considerable experience in Industrial Pretreatment Monitoring and Regulation.

B. David Little
General Manager, Laboratory Services, Asheville, NC Laboratory
Technical Director, Inorganic Laboratories

David Little provides technical advice to the management of HydroLogic Laboratories, Inc. Additionally, he manages the operations of the Asheville laboratory which has trace metals and general chemistry capabilities. He has gained considerable experience in several industrial settings as well as in contract laboratory environments. Mr. Little specializes in atomic absorption spectrophotometry.

Linda McKenzie
Aquatic Biomonitoring Supervisor, Raleigh, NC Laboratory

Linda McKenzie is responsible for the coordination of all technical aspects of the Aquatic Biomonitoring Division including: client relations; project management; test scheduling; data analysis and review; and administrative organization of the laboratory. Her experience is based in aquaculture and mariculture research.

Pomeroy Smith, II
General Manager, Raleigh, NC Laboratory

Pomeroy Smith is responsible for the administrative and technical operations of the Raleigh laboratory. This includes client services, project management, supervision of laboratory personnel and administrative organization of the facility.

Eric Bolin
General Manager, Salisbury, NC Laboratory

Eric Bolin manages the administrative and technical operations for the drinking water and wastewater division of the Salisbury laboratory. He is responsible for: QA/QC management; and technical assistance and review of biological analyses for drinking water, BOD, ammonia nitrogen, total suspended solids, total dissolved solids and fecal coliform.

Dinah H. Trammel
Senior Project Manager, Corporate Office, Asheville, NC

Dinah Trammel is responsible for managing major projects from the proposal stage through final reporting. She brings to this position extensive expertise from her prior experiences with HydroLogic. Her twenty years of experience enables her to provide practical, valuable advice to our clients. Dinah's main responsibility is to keep our clients aware of their project's progress in the laboratory and be the interface between our clients and our laboratories.

Thomas D. Smith, Jr.
Laboratory Manager, Columbia, SC Laboratory

Thomas Smith coordinates and directs the Columbia laboratory. He is in charge of GC, GC/MS and organic sample preparation and is responsible for specialized support analyses for underground storage tank and site remediation projects utilizing gas chromatography and mass spectometer analyses. Mr. Smith has over nine years experience in environmental organic chemistry and has extensive technical expertise in GC and GC/MS instrumentation.

Vernice Thomas
Laboratory Manager, Macon, GA Laboratory

Vernice Thomas coordinates and directs the laboratory at the Macon, Georgia facility. Her experience includes analytical chemistry, spectrophotometry, wet chemistry techniques, quality assurance and quality control. Vernice is certified for wastewater and drinking water analysis and has over eight years of experience in analytical laboratory work.

Teresa McClanahan
Laboratory Manager, Brentwood, TN Laboratory
QA/QC Coordinator, Inorganic Laboratories

Teresa McClanahan is an analytical chemist with three years experience in quality assurance and control, technical personnel training, and multimedia analytical testing. Ms. McClanahan has six years of experience utilizing atomic absorption spec

troscopy, automated colorimetric analysis, UV/Vis spectrophotometry and wet chemistry techniques. She has been involved in state laboratory certification programs and has a thorough knowledge of EPA protocols for sampling and analysis.

Melissa J. Russell
QA/QC Officer, Frankfort, KY Laboratory

Melissa Russell coordinates the development, implementation, and management of the Quality Assurance/Quality Control (QA/QC) program. She performs internal audits and reports her findings and recommendations to HydroLogic's management. Melissa is responsible for the QA/QC manual and SOP documentation as well as HydroLogic's state certification program. She also coordinates industrial on-site audits.

Randy Greaves, Ph.D.
Vice President, (HydroLogic Laboratories, Inc.) Denver, CO Laboratory

Randy Greaves is responsible for directing all laboratory operations at our Denver laboratory. He has over fifteen years of environmental laboratory experience including project management, technical and operational laboratory management. His expertise encompasses CLP, USATHAMA, COE, NAVY CLEAN, AFCAA, USACE, DOD and commercial specified guidelines and standard protocols. Mr. Greaves has considerable experience defining, communicating and assessing program and project specifications to match laboratory services to the client's needs.

Tyler H. Garber
Laboratory Manager (HydroLogic Laboratories, Inc.) Denver, CO Laboratory

Ty Garber supervises the administrative and technical operations of the wet chemistry, ion chromatography, and metal analyses division of the Denver laboratory. He is responsible for the management and productivity of this section. Mr. Garber's nine years of analytical experience has encompassed technical, operational, and administrative responsibilities in both research and environmental production facilities.

HydroLogic QA/QC Summary

The purpose of HydroLogic's Quality Assurance/Quality Control (QA/QC) program is to ensure that all clients receive analytical data that meets their need for completeness, precision, accuracy, representativeness, comparability, legal defensibility, and scientific validity. This Quality Assurance program is an integrated system that combines planning, assessment, and continual improvement. Quality Control is a daily process of verification and documentation to ensure required levels of quality. This program is available for review in HydroLogic's QA/QC manuals.

This chapter presents the following information:

- Organizational responsibility for the QA/QC program
- The quality practices HydroLogic uses to produce quality data
- HydroLogic's laboratory functions and a general flow diagram of sample handling procedures

Organizational Responsibility

The Board of Directors issues directives in regard to company policies, in particular, HydroLogic's quality assurance program. Implementation of the program is the responsibility of all employees.

To ensure consistency, completeness, and accuracy of data generated at HydroLogic Laboratories, Inc., the QA/QC Officer conducts both systems and operations audits. The results from the audits are submitted to management in order to summarize the areas where planning, assessment and improvement are necessary.

Quality Practices

Material Procurement and Control of Quality-Related Materials

The quality of materials procured for use in the laboratories must meet specified requirements that may necessitate testing prior to acceptance. Once acceptance testing is completed, control measures are taken to ensure that the quality of the material is maintained.

Chain of Custody

With the use of a chain of custody form, HydroLogic ensures the security and integrity of samples submitted for analysis. When samples are received, they are checked for damage, completeness and proper preservation. The Sample Custodian signs the chain of custody form and logs the samples into the laboratory analysis system.

The chain of custody record is the initial step in the HydroLogic system of tracking samples through preparation and analysis. Chain of custody reaches its conclusion at the disposal site. Sample retention and disposal complies with all applicable federal, state and local laws and regulations.

Sample Identification

Integrity of the sample is maintained throughout the entire analytical process by assigning sample identification numbers to the client's samples upon receipt. A list of sample identification numbers, cross-referenced to the client's internal identification numbers, is then generated for the project.

HydroLogic Laboratories, Inc., has adopted a sample tracking system that ensures data can be used as valid evidence should it become subject to litigation. This documentation encompasses chain of custody and sample notification forms, project logbooks, laboratory notebooks, instrument operation logbooks, instrument printouts and final analytical reports.

Sample Notification Forms

Sample notification forms are generated at HydroLogic to alert laboratory personnel that samples have been received. This notification, which is generated in sample receiving, details the specific analytical requirements of each sample. Once submitted to the laboratory, analyses are scheduled based on allowable holding times. The notification form also ensures that the sample will be analyzed using the appropriate methodology and correct reporting format.

Calibration Procedures

HydroLogic has a formal calibration program that utilizes calibration standards obtained from chemical suppliers with certification of purity and concentration. These commercial standards are used to prepare working standards. Working standards are made at appropriate concentrations to include the linear range of the calibration curve. Calibration check samples, obtained from a dissimilar source, are used to verify concentrations and ensure precision and accuracy. These procedures verify that instrumentation has the proper range, accuracy, and precision as specified in relevant analytical methods.

Preventative Maintenance

Preventative maintenance procedures are performed with the same or greater frequency suggested by the manufacturer. Written records are kept to document maintenance operations by analysts trained in equipment trouble-shooting. Performance criteria checks are utilized to establish a need for operating adjustments, maintenance, or repair. Preventative maintenance schedules are in place to prevent instrument failure and ensure instrument/personnel efficiency.

Quality Control Samples

Quality control samples (blanks, spikes, duplicates) are used to monitor laboratory performance throughout the network and to ensure operations are within prescribed requirements for accuracy and precision. Analysis of quality control samples is carried out using the same procedures that are used for field samples. The number and frequency of these samples are determined by method specifications. Analytical results of quality control samples are used to document the validity of data and to control data quality within predetermined acceptance limits.

Standard Operating Procedures

In order to standardize and document laboratory operations and routine analyses, detailed Standard Operating Procedures (SOPs) are maintained. These documents are designed to be bench manuals for daily use. The SOP includes pertinent details of each procedure to support the utility of the data generated by HydroLogic. After review, each SOP is approved with the signatures of the Laboratory Director, the Laboratory Supervisor and the QA/QC Officer.

Documents are controlled by an SOP numbering system, an SOP distribution list, and an archive file for outdated documents. SOPs are located where users can easily access them, and revision dates are prominently displayed to ensure that the current version is being referenced.

Biomonitoring Practices

The aquatic biomonitoring laboratories provide toxicity testing and biomonitoring support for municipalities, industries and commercial testing laboratories. Good Laboratory Practice (GLP) procedures are utilized by all personnel involved in test organism culture, generation and analysis of data, and general laboratory maintenance.

The aquatic biomonitoring laboratories maintain active cultures of all species used for on-site toxicity testing. *Ceriodaphnia dubia, Pimephales promelas, Daphnia pulex, and Selenastrum capricornutum* are cultured according to standard EPA protocols and recommendations. If it is necessary to supplement the genetic diversity of the cultures on hand, organisms are obtained from EPA Cincinnati or North Carolina Department of Environment, Health, and Natural Resources (NCDEM).

Sample Collection Procedures for Biomonitoring

The aquatic biomonitoring laboratories will generally rely on their clients to collect and ship effluent samples for toxicity tests. The laboratory staff will provide all necessary sample and shipping containers to the client along with sampling guidelines and chain of custody documentation.

Effluent sample collection by HydroLogic is available upon request and is collected at the point of discharge to the receiving stream or at the sampling location specified in the NPDES permit. The type of sample collected will depend on the type of toxicity test being conducted and the requirements of the discharge permit.

Grab samples are collected using appropriate containers that have been chemically cleaned prior to use. All samples are maintained at 1 to 4° C during storage and shipment. Composite samples are collected in a commercial sampling device such as a HydroLogic 100A Sampler.

Data Validation and Reporting

Data validation is performed from analysis to the final report stage. It begins with the analyst and continues with independent reviewers including the Laboratory Supervisor, the QA/QC Officer and the Laboratory Manager. The reviewer verifies that the reported results correspond to the data acquired and ensures that the data processing and calculation were done correctly. This process also serves as a monitor for sample traceability and as an audit for quality control samples. This review system ensures that the data is valid for the intended use prior to reporting.

If requested, the final report includes a summary of QC data to meet the needs of the project. Final data presentation is reviewed and approved by the Laboratory Director before release to confirm that the objectives of the project have been met.

Records Management

To ensure that all documents are accessible and traceable, HydroLogic Laboratories, Inc., maintains a records management system. Documentation is initiated at sample log-in with the chain of custody form and continues with all log books, graphs, and notebooks. Project records (raw data, chain of custody) and quality/operations data (log books, etc.) are kept separately.

All analytical data files and associated documentation are maintained in a secured central repository that safeguards them from tampering and physical loss or damage.

SOP and QA/QC Manual revisions and distribution are controlled by the QA/QC Officer. Documents are retained in accordance with applicable laws and regulations.

Nonconformance and Corrective Action

The QA/QC plan defines nonconformance according to standard operating procedures and methods. HydroLogic employees are required to report all observed or potential nonconformances to a supervisor. Upon reporting the nonconformance, the individual will prepare and sign a corrective action form and notify the QA/QC Officer. In uncontrollable situations, work will be stopped until the nonconformance situation can be resolved.

HydroLogic's analysts are trained to recognize, document, and correct problems that might affect quality. This system of review and corrective action ensures nonconformance events are resolved and recurrences avoided. This system is maintained through a cooperative effort between the analyst, section supervisor, laboratory supervisor, QA/QC officer and laboratory manager.

All corrective action forms are filed in project files.

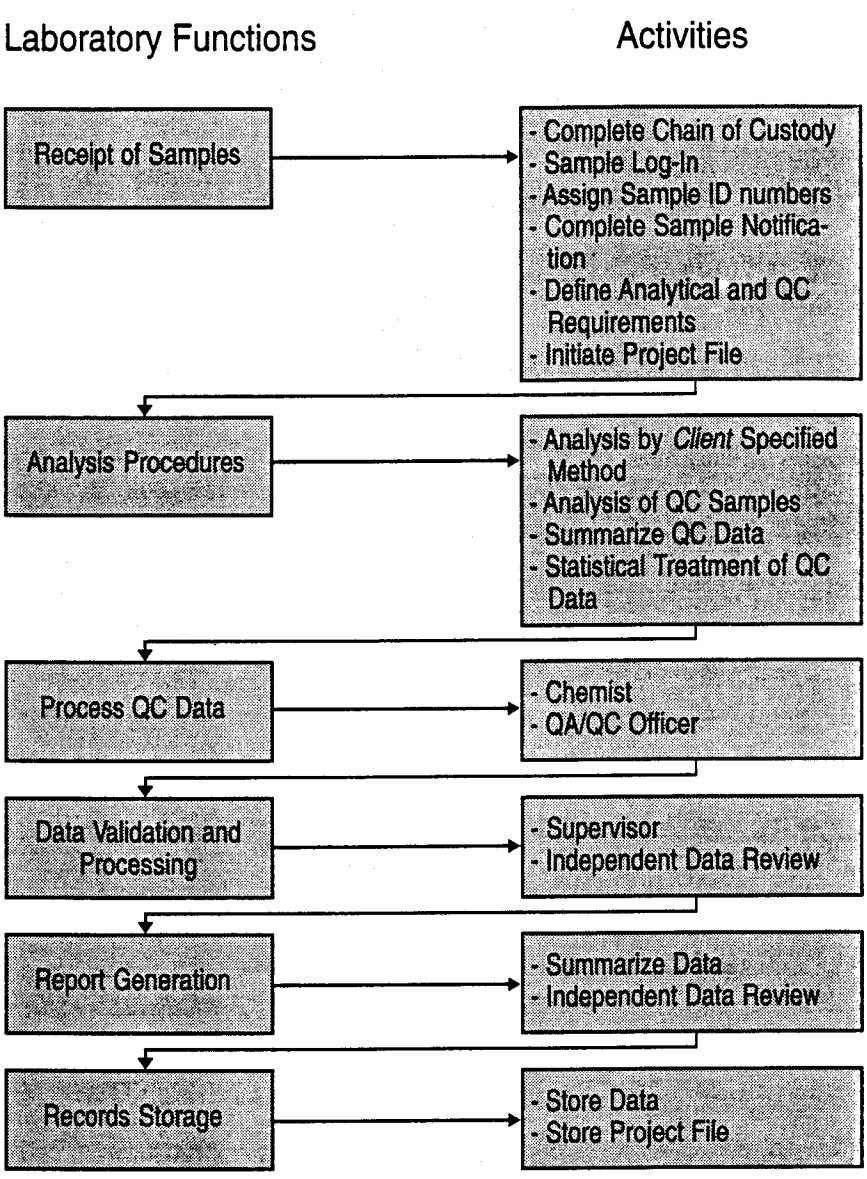
Personnel Qualifications and Training

All employees are trained to efficiently execute the procedures which they perform in the laboratory. This training occurs through apprenticeship as experienced analysts and section supervisors answer questions and provide direct supervision. Once the analyst understands and can perform a procedure, it

is documented on a Training Check List for Lab Personnel. This form is unique for each employee, and is continually updated to reflect the entire spectrum of skills that the employee has acquired.

Sample Tracking

Based on HydroLogic's quality control procedures, the following chart shows the various laboratory functions and illustrates how a sample is tracked through the HydroLogic system from the time it arrives at the laboratory through completion of the analysis.


Laboratory Functions
Activities
Receipt of Samples
- Complete Chain of Custody
- Sample Log-In
- Assign Sample ID numbers
- Complete Sample Notification
- Define Analytical and QC Requirements
- Initiate Project File
Analysis Procedures
- Analysis by *Client* Specified Method
- Analysis of QC Samples
- Summarize QC Data
- Statistical Treatment of QC Data
Process QC Data
- Chemist
- QA/QC Officer
Data Validation and Processing
- Supervisor
- Independent Data Review
Report Generation
- Summarize Data
- Independent Data Review
Records Storage
- Store Data
- Store Project File

Industrial Hygiene Plan

HydroLogic has established a complete Industrial Hygiene Plan that is used to train all personnel in the following areas:

- Proper use of safety materials
- Proper handling of chemicals, gas cylinders, and hazardous waste
- Proper response to all emergencies including fire, chemical spills, and medical crises
- Proper disposal of all hazardous waste, ensuring that HydroLogic follows both federal and state guidelines for hazardous waste handling

The Industrial Hygiene Plan is also used to guarantee that laboratory safety equipment is in good condition. Routine monitoring ensures that hoods, sprinkler systems, alarms, eyewash/shower stations and safety supplies are up to standards.

The Industrial Hygiene Plan is also used to protect the health and safety of all personnel. All personnel are regularly checked for personal exposure to chemicals in the laboratory, and routine physicals are scheduled with a specialized toxicologist.

Waste Minimization Plan

It is the policy of all HydroLogic companies to access and implement strategies of waste minimization in all aspects of operations. A continual effort will be made to identify opportunities for waste reduction in our laboratories and field operations.

All levels of management and personnel will be involved in these programs in order to achieve Pollution Prevention goals while maintaining environmental regulatory compliance. Specific goals will be defined for individual facilities in the HydroLogic group of companies.

HydroLogic endorses the concept of Sustainable Development-Economic Growth sustained by a Protected Environment. Through this program, HydroLogic will set responsible standards of waste reduction for its firms.

Certifications and Accreditation

This chapter outlines the state certifications and accreditation held by HydroLogic Laboratories. HydroLogic is currently certified to conduct analyses in a large number of states. In addition, all HydroLogic locations are striving to expand their certifications and accreditation.

The quality of data produced by HydroLogic is verified not only by a rigorous QA/QC program, but also through participation in external studies sponsored by independent third-party sources. All locations are involved in various performance evaluation (PE) programs. These programs are administered by government agencies and state certifying organizations as proof of analytical criteria compliance.

The following is a list of important environmental associations that HydroLogic supports to promote understanding and communication within the industry:

- American Chemical Society (ACS)
- American Society for Quality Control
- Colorado Association of Commerce and Industry (CACI)
- Colorado Hazardous Waste Management Society (CHWMS)
- International Association of Environmental Testing Laboratories (IAETL)

State Certifications and Approvals

The following chart lists the states in which HydroLogic is certified to conduct specific environmental analyses.

Lab Location	State Certification
Asheville, North Carolina	NC / SC / WV / TN
Lumberton, North Carolina	NC / SC
Raleigh, North Carolina	NC / SC
Salisbury, North Carolina	NC / SC
Columbia, South Carolina	SC / NC / TN
Frankfort, Kentucky	NC / KY / NJ / SC / WV / TN / IN
Denver, Colorado	CO / ND / KS / KY / MT / NM / NC / SC / SD / UT / VA / WA / WY
Naples, Florida	FL
Brentwood, Tennessee	NC / TN / SC
Macon, Georgia	GA

Project Experience

HydroLogic Laboratories, Inc., is a dynamic and rapidly growing corporation. As a result of this growth, HydroLogic is constantly increasing the diversity of its clients.

HydroLogic provides testing for commercial and government clients including: water and wastewater treatment facilities; utilities; landfills; hazardous waste management companies; engineering, geo-technical and legal firms; electronics, manufacturing, textile, paper, metal finishing, brewing and agricultural industries.

This chapter illustrates the breadth of experience that HydroLogic has in performing analyses for commercial and government clients.

Selected Commercial Projects

Cogentrix, Inc. - Lumberton, NC
1989 - Present

Perform routine and non-routine NPDES wastewater analyses for six major privately owned co-generation power plants. Analyses that are shared between the network of laboratories include: 126 priority pollutants; stormwater; biomonitoring; and a diverse list of inorganics.

Highway 36 Land Development Company - Last Chance, CO
1989 - Present

Highway 36 is the newest operating hazardous waste landfill in the country. HydroLogic's Cenref Laboratory has been involved with analytical testing at the facility for the past three years. Initially, the laboratory performed background monitoring of soils and groundwater prior to site operation.

Currently, Cenref is analyzing surface waters, leak detection system samples, and groundwaters during the operational phase of the facility. Over 40 wells are sampled and analyzed quarterly for the complete range of analytical parameters.

In addition to the environmental analytical assessments for the facility, Cenref also performs waste characterizations for Highway 36 to assess the applicability of the waste for possible treatment and disposal at their waste facility.

Non-Profit research organization (name withheld to preserve confidentiality)
1992

Determined toxicity of a compound according to TSCA regulations under GLP protocols. Methods used included 797.1300, a *Daphnia* acute toxicity test, and 797.1400, a fish acute toxicity test found in 40CFR 797.

Textile manufacturer (name withheld to preserve confidentiality)
1992

Identified and confirmed the causative agent of toxicity in an effluent. HydroLogic is presently working with the client to address operational changes necessary to remove the toxicant. Methods used included Phase I Acute Toxicity Identification Evaluation as specified by EPA 600/3.88/034.

Viar & Company - Washington, DC
1988 - 1990

Participated in a research and development project designed to evaluate tuning guidelines for GC/MS work. Awarded a contract for the analysis of pesticides, volatiles, and semi-volatiles in high level samples.

Westinghouse - Hanford, WA
1988 - 1989

Performed waste characterizations on 250 drums stored at a DOE site. The purpose of the testing was to evaluate each drum sample to assess proper disposal options. The testing involved a complex analytical scheme which encompassed both qualitative and quantitative techniques for inorganic and organic evaluations.

Whirlpool Corporation - Columbia, SC
May 1992 - Present

Sampled and analyzed fuel sources to identify hydraulic fluids containing PCBs and to determine proper disposal decisions as enforced by the EPA using RCRA methods. HydroLogic used EPA SW-846 guidelines for PCBs. Over 120 samples were analyzed.

Selected Government Projects

Sanibel Wastewater Treatment Facilities - Sanibel, Florida
1993 - Present

HyroLogic developed a unique partnership with the city of Sanibel by designing a program of flexible cost savings, cost sharing and liability control. The agreement called for HydroLogic to implement a full range of wastewater treatment services: construction and repair, plant operation, supervision of outside/contract service vendors and analytic laboratory testing. Strict professional standards were required due to the environmental sensitivity of the area.

City and County of Denver - Denver, CO
1989 - Present

Analyzed groundwater samples taken from monitoring wells at the Lowry Landfill near Denver. Typical analytes included volatiles, semi-volatiles, pesticides, PCBs, and inorganics by SW-846 methods.

Denver Water Department - Denver, CO
1989 - 1990

A pilot plant with one million gallons per day capacity was constructed to demonstrate the feasibility of converting wastewater to drinking water. Cenref was selected to analyze the effluent for all organics normally looked for in drinking water but at lower detection limits due to the high visibility of the project. The quality of the data was a significant factor since numerous agencies would be reviewing the project.

Environmental Protection Agency - Denver, CO
1985 - 1990

Performed Routine Analytical Services (RAS) for organics under the Contract Laboratory Program (CLP), which was established to provide consistent analytical services for Superfund. To support their investigations, Cenref provided data that was of documented quality. This was accomplished by operating a comprehensive Quality Assurance program involving analytical standards, performance evaluation samples and blind check samples, as well as chain of custody procedures, and document control.

North Carolina Department of Corrections - Asheville, NC
1991 - Present

Provide testing of water samples from nine correctional facilities. Composite sampling is performed bi-monthly for bacteriological testing. HydroLogic is required to conform to Standard Methods for Wastewater and Water (APHA) by a North Carolina state certified laboratory.

T.C. Analytics Inc. - Norfolk, VA
1991 - Present

This two-year contract requires analyses of soil and water samples taken from military bases. Typical analytes include volatiles, semi-volatiles, pesticides, herbicides, organics, and PAHs. This work requires that CLP QA/QC be provided with the report.

U.S. Forest Service - Asheville, NC
1991 - Present

Perform bacteriological testing of wastewater samples for five treatment plants and provide operations and maintenance of sites. HydroLogic is required to conform to Standard Methods for Wastewater and Water (APHA) by a New York state certified laboratory.

Representative Clients

The following is a brief list which is representative of HydroLogic's clients.

Amoco Production Company
Anheiser Busch Company
BASF
Burlington Knitted Fabric
Campbell Soup
Chen Northern
Colorado Dept. of Health
Conoco, Inc.
Converse, Inc.
Days Inn
Ecology & Environment
EPA
Ethan Allen
Georgia Pacific
Gerber Company
Hewlett-Packard
Hitachi
Holiday Inn Corp.
Kayser Roth
Pepsico Bottling
Phillips Pipeline Company
Public Service Co. of Colorado
Reynolds Metals Corp.
Rockwell International
Seneca Foods Corp.
Shell Oil Company
Sonoco Products
Texas Eastern
TranscoGas Pipeline
Unocal Chemicals
Western Area Power Admin.
Westinghouse

HydroLogic Laboratory Backgrounds

The laboratories within the HydroLogic network have a common history of providing high quality analytical data and ensuring client satisfaction. This appendix provides an abbreviated history of each HydroLogic location and describes how a commitment to quality has made the organization what it is today.

HydroLogic Asheville Laboratory
Asheville, NC

The HydroLogic Asheville Laboratory is the corporate headquarters of HydroLogic Laboratories, Inc. Originally formed as Wastewater Services in 1973, the company offered comprehensive wastewater treatment plant operations and performed general chemistry services mandated by North Carolina regulations.

In 1986, Wastewater Services was acquired from its founder and became the cornerstone of the group of companies known as HydroLogic. The corporate name remained Wastewater Services until 1990. The basic commitment to providing quality analytical services has been a common theme throughout the company's metamorphosis.

The Asheville laboratory continued to expand its client base to include treatment plants, industrial clients, municipalities, and private individuals. With this expansion, the variety of the analyses offered to clients increased, necessitating relocation in late 1990 to a larger facility.

Currently, the Asheville laboratory offers a full spectrum of inorganic chemical analyses. Additionally, the Asheville facility provides wet chemistry and spectrographic analysis.

HydroLogic Lumberton Laboratory
Lumberton, NC

The HydroLogic Lumberton Laboratory has been in existence for 17 years and was previously operated under the name of Professional Environmental Laboratory of Lumberton. In October, 1989, it was acquired by Wastewater Services (HydroLogic). The name was then changed to Professional Lab and Environmental Services, Inc., and it became part of the growing HydroLogic network.

The laboratory officially changed its name to HydroLogic Laboratories, Inc., in June, 1991. Highly regarded by state certification and requlatory officials, the Lumberton facility provides services to municipalities, industrial clients, and individual clients in North Carolina and South Carolina.

HydroLogic Raleigh Laboratory
Raleigh, NC

The HydroLogic Raleigh Laboratory opened in 1985 under the name of Carolina Environmental Inc., and specialized in NPDES Aquatic Biomonitoring. Last year, the lab increased its certifications to include acute and chronic Ceriodaphnia and Fathead Minnow testing for North Carolina.

The staff has grown to four biologists. The Raleigh team has successfully completed toxicity identification evaluations and toxicity reduction evaluations, and has extensive research capabilities for non-routine testing on aquatic species.

In September of 1992, HydroLogic purchased Harden Environmental Management of Durham, North Carolina. This facility was merged into the Raleigh facility, which added NPDES wet chemistry capabilities.

HydroLogic Salisbury Laboratory
Salisbury, NC

The HydroLogic Salisbury Laboratory was purchased by HydroLogic Laboratories, Inc., in the last quarter of 1989. Originally named Hamilton Labs, it was strictly a certified drinking water laboratory.

After becoming part of the HydroLogic network, the lab added wastewater capabilities and became certified in North Carolina for NPDES parameters including biological and inorganics. The lab now has extensive contracts to test public and private drinking water in the south central section of North Carolina.

HydroLogic Columbia Laboratory
Columbia, SC

The HydroLogic Columbia Laboratory began operations as an aquatic toxicity lab in 1989, under the name of Toxicity Testing Laboratory.

Following HydroLogic's purchase of the lab in 1991, additional staff and GC instrumentation were added to address the UST market in South Carolina. Following certification in 1992, growth in the organic section of the laboratory has been remarkable. Today, the HydroLogic Columbia Laboratory is one of the leading UST laboratories in the region.

HydroLogic Frankfort Laboratory
Frankfort, KY

The HydroLogic Frankfort Laboratory began operations in 1985 as Mass Spec Services, offering GC/MS analyses. Within a year, additional GC instrumentation was purchased for pesticide and PCB analyses. Later that year, the lab moved to its present location and added more personnel and GC/MS instrumentation.

HydroLogic purchased the lab in 1990. An increasing work load from the UST markets required the purchase of more instrumentation and the addition of both technical and administrative staff. By October, 1991, the facility doubled its size to contend with growing sales attracted by the lab's reputation. Today it is one of the leading organic labs in the Ohio Valley and provides analytical services to clients in a six-state area.

HydroLogic Laboratories, Inc.
Denver, CO

HydroLogic's Denver Laboratory has been performing analytical chemistry testing since the early 1930's. Initially servicing the oil and gas industry, their capabilities have grown to encompass a full scope of analytical services. Their clients include governmental agencies, engineering and consulting firms, electronics, manufacturing, brewing and agricultural industries.

This lab was owned by Panhandle Eastern prior to its acquisition by HydroLogic in January. Under the leadership of the HydroLogic parent company, the Denver location continues its planned growth with major investments in new instruments and the hiring of additional qualified staff. The Denver lab specializes in environmental analyses including groundwater monitoring, priority pollutant testing, RCRA characterizations, NPDES wastewater monitoring and drinking water analysis.

HydroLogic's Denver lab served as a Contract Laboratory for the Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) for organic analysis from 1985 to 1990. They participate in numerous state certification programs and are certified by several state agencies for environmental monitoring.

With highly experienced personnel and state-of-the-art analytical instrumentation, the Denver lab meets today's most demanding environmental problems in a reliable, fast and cost-efficient manner.

HydroLogic Brentwood Laboratory
Brentwood, TN (Nashville)

The HydroLogic Brentwood Laboratory opened in 1990 as a laboratory for the ADVENT Group, Inc., an environmental engineering firm. The laboratory was purchased by HydroLogic in June of 1993. The laboratory specializes in trace metals analysis and can also perform a large variety of other inorganic parameters. The lab has recently increased its capabilities to include toxicity characteristc leaching procedure (TCLP) extractions.

The laboratory holds drinking water certification in Tennessee and wastewater certification in North Carolina. The lab's clients consist of national and international industries as well as several Superfund sites.

HydroLogic Naples Laboratory
Naples, FL

The HydroLogic Naples Laboratory opened in 1984 to support Contract Operations Group in Naples. It became part of the HydroLogic network in early 1993. The lab specializes in compliance monitoring related to the Safe Drinking Water Act, the effluents of domestic wastewater, and ground water requirements in nutrients and drinking water metals.

The lab has expanded to provide additional services to provide support for an ever-increasing clientele of water and wastewater treatment plants now numbering over 140. It accomplished this after the acquisition by HydroLogic when it moved to a new location that doubled its physical size, and by doubling its staff.

HydroLogic Macon Laboratory
Macon, GA

The HydroLogic Macon Laboratory, formerly a Tribble & Richardson lab and established in 1981, is certified in microbiology in Georgia, and is in the process of gaining certification for inorganics and metals in the state. The lab collects its own field samples for its clients. It performs groundwater, wastewater, and drinking water analyses. The lab joined the HydroLogic lab network in 1993.