Groundwater quality and laundromat wastewater: Summit Lake, Wisconsin. [DNR-029] 1987

Saltes, Jack

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Wisconsin Groundwater Management Practice Monitoring Project No. 29

GROUNDWATER
Wisconsin's buried treasure

Wisconsin Department of Natural Resources

GROUNDWATER QUALITY AND LAUNDROMAT WASTEWATER: SUMMIT LAKE, WISCONSIN

Jack Saltes, M.S. Environmental Engineer
Wisconsin Department of Natural Resources
North Central District, Rhinelander, Wisconsin.

[1987 ?]

ABSTRACT

Rural laundromats in northern Wisconsin are, many times, limited to on-site land disposal of their laundry wastewater. The potential for contamination of groundwater by the application of untreated laundry wastewater has been largely unknown. In this investigation, groundwater quality was determined at a laundromat site that utilizes a disposal (seepage) pond. Through discharge to this pond for almost 25 years, the unintentional result was the establishment of a unique wetland system in which natural processes have been effective in assimilating the organic fraction of laundry wastewater. Elevated concentrations of inorganic parameters in a monitoring well close to the disposal pond confirm the migration and potential impacts of inorganic solutes. More distant monitoring wells showed no elevated inorganic concentrations based on horizontal groundwater movement. Vertical migration of the contaminants was not studied and is unknown. The organic fraction of laundry wastewater was biologically degraded indicating some level of biological treatment is desirable. In rural settings, constructed wetlands may offer a cost-effective disposal option provided on-site disposal is the only alternative. Tolerance for elevated groundwater concentrations of inorganic solutes is predicated on pertinent groundwater quality standards.

INTRODUCTION

Rural laundromats in Wisconsin have limited wastewater disposal options. Remoteness and wastewater volumes preclude the cost effectiveness of transporting it to a sewage treatment system or landspreading it on agricultural lands. On-site disposal is usually practiced.

The Summit Lake Laundromat in Langlade County of northern Wisconsin has been discharging approximately 40,000-117,000 gallons of untreated laundry wastewater per month since 1963 to a disposal pond behind the facility. The potential for contamination of groundwater by the land application of untreated laundry wastewater is largely unknown. A paucity of information exists, both statewide and nationally, on the fate of detergent chemicals in groundwater/subsurface systems. Most investigations have studied the biodegradation of detergent chemicals in septic tank drainage systems (Larson 1984, Harkin et. al. 1983), associated with other compounds (Thurman et. al. 1986), or in natural waters (Larson et. al. 1983, Larson and Vashon 1983, Larson and Games 1981, Larson and Payne 1981).

Laundry detergent chemicals consist largely of anionic, nonionic, and cationic surfactants with the anionic sulfonated compounds comprising 65% of all surfactants (Llendado and Jamieson 1983). Cationic surfactants are finding increasing use as antistatic and fabric softening agents (Lewis and Wee 1982). Detergents also contain builders or softeners such as sodium carbonates and aluminosilicates, processing aids (sodium sulfates) and whiteners (boron).

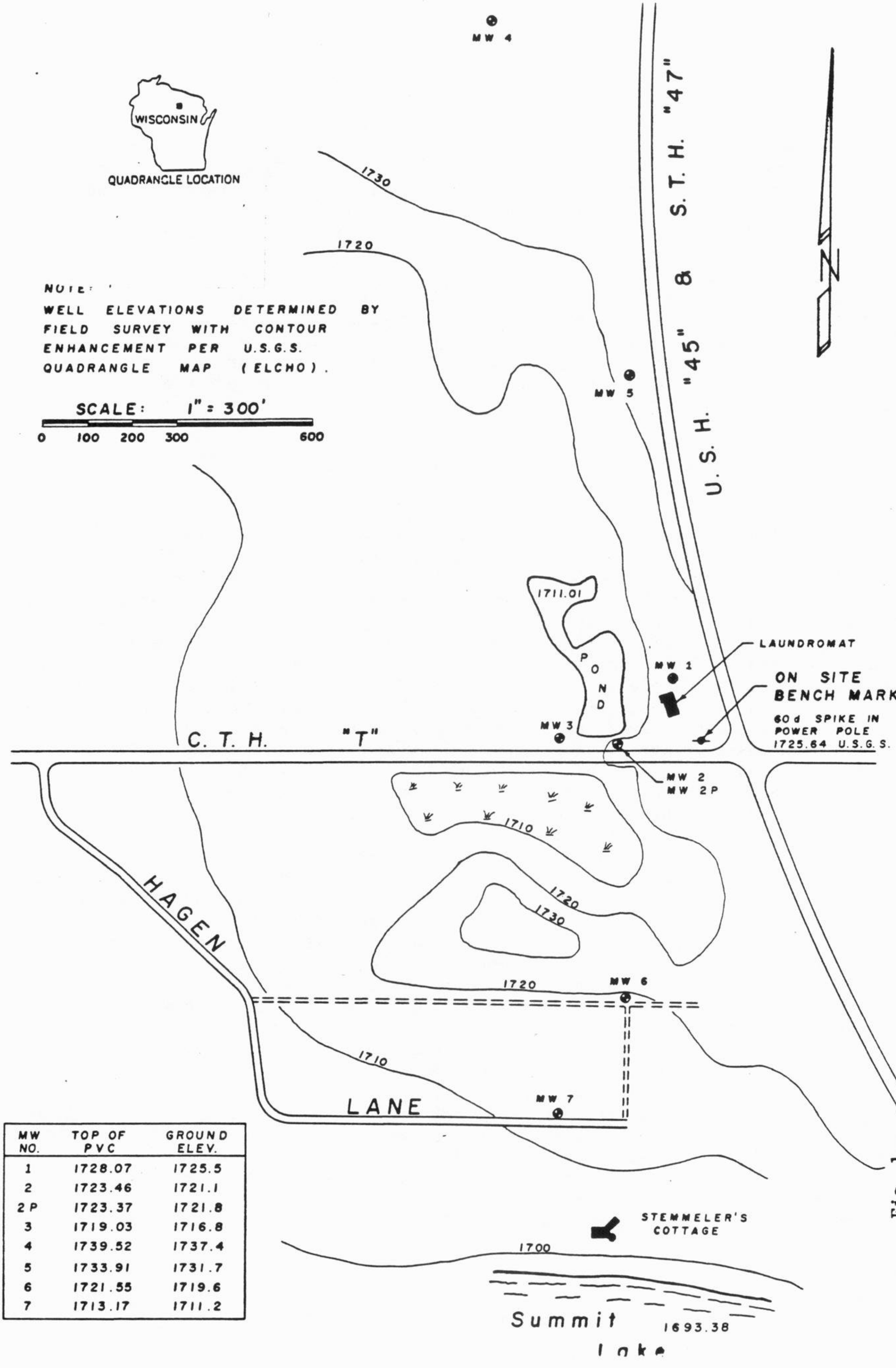
This study was conducted to determine groundwater quality near a laundromat disposal pond. The results are, in part, to help guide a regulatory agency in assessing the appropriateness of land treatment for rural laundromats and expected impacts on the groundwater resource.

MATERIALS AND METHODS

Groundwater quality was investigated through the construction of eight water table monitoring wells in the area of the laundromat (Figure 1). All two-inch PVC monitoring wells were drilled in 1984 and 1986 by hollow-stem or rotary with driven casing methods (STS Consultants 1986) according to guidelines of the Wisconsin Department of Natural Resources (Wisconsin DNR 1985). All wells were properly developed prior to sampling.

Prior to collection of groundwater samples, groundwater elevations were measured to the nearest hundredth-of-a-foot in all wells. Wells were then purged of three-five well volumes with a hand PVC bailer. Groundwater samples from each well were collected within 24 hours of purging. Samples were immediately field filtered using a Millipore® prefilter (AP2014250) and .45 um Millipore® filter (HVLP14250) through Geofilter® filtering apparatus. These filters were selected because of their applicability for low-level MBAS and COD testing as shown through filter blanks (non-detects) and their excellent percent recovery (93 and 110%) of standard MBAS solutions. All filters were rinsed with 1000 mls of distilled water prior to filtering the actual sample.

Samples were preserved according to standard preservation techniques for the parameters of interest and shipped to the Wisconsin State Laboratory of Hygiene for analysis. All analytical methods follow guidelines established under the Clean Water Act Regulations (Federal Register 1986).



NOTE:
WELL ELEVATIONS DETERMINED BY FIELD SURVEY WITH CONTOUR ENHANCEMENT PER U.S.G.S. QUADRANGLE MAP (ELCHO).

MW NO.	TOP OF PVC	GROUND ELEV.
1	1728.07	1725.5
2	1723.46	1721.1
2 P	1723.37	1721.8
3	1719.03	1716.8
4	1739.52	1737.4
5	1733.91	1731.7
6	1721.55	1719.6
7	1713.17	1711.2

Fig. 1

SITE SURVEY SUMMIT LAKE LAUNDROMAT

LHM SURVEYING
6006 HILGEMANN ST.
SCHOFIELD, WI. 54476

RDE LHM M-528 15 AUG. 86

Parameters selected for analysis included those associated with laundry detergents, namely phosphorous, sodium, sulfates, and chlorides. Boron, associated with whiteners, was analyzed only in the 1987 samples. Indicator parameters of conductivity, total dissolved solids, BOD_5, COD, alkalinity, hardness, and pH were also analyzed. The most widely used method for the determination of anionic surfactants in environmental samples, the methylene blue active substance method (MBAS), was also employed.

Wastewater samples were collected across the disposal pond in three locations: influent, cattail area, and a perched water table monitoring well contiguous with the pond. These locations represented the southern extent of the pond and were selected for a cursory assessment of the pond's assimilative capacity.

Data was analyzed using appropriate statistical procedures (Unwin and Miner 1985) and guidelines contained in Wisconsin Administrative Code Chapter NR 140 - Groundwater Quality.

RESULTS AND DISCUSSION

The disposal pond at the Summit Lake laundromat is an active biological system (Barnum and Cascone 1986). Through discharge to a lowland behind the laundromat, the unintentional result was the establishment of a unique wetland system in which natural processes have been effective in assimilating the biodegradable fraction of laundry wastewater (Figure 2). The pond is microbiologically active, both aerobically and anaerobically. Sulfur bacteria utilize sulfates in anaerobic areas of the pond with a reduction to hydrogen sulfide (personal communication, Proctor and Gamble). The association of purple bacteria mats in the pond and evolution of hydrogen sulfide gas are evidence of such activity. Alkyl sulfides and carbonyl sulfides may also be released from a natural reducing environment (Keeney 1983). Surfactants (MBAS) and other organics (BOD, COD) are readily degraded under aerobic conditions across the pond while less available and more mobile inorganics are not as readily assimilated (Figure 2). Most microbial activity centers around organic compounds as the energy source (Keeney 1983).

Underlying soils of the site consist of Pence sandy loam and Antigo silt loam, well-drained soils underlain by sand and gravel (Soil Conservation Service, 1982). Monitoring well installation by the Wisconsin DNR and actual pond borings by Proctor and Gamble in 1986 revealed a 6-8 inch clay lense underlying the pond site in a suspected narrow north to south configuration. Perched water is found at the site above the clay lense approximately 15 feet deep from the surface.

Groundwater in the aquifer is unconfined, and the water table is approximately 40-50 feet below the ground surface. Groundwater in the study area generally flows south but is greatly influenced by Summit Lake, as inferred from the water table map prepared from measurements of water levels on August 12 and October 31, 1986 (Figure 3). Water levels at these times were typical of levels seen during the study period. The water table fluctuates 8-12 inches because of seasonal variations in recharge from precipitation.

Seepage velocities were estimated using Darcy's Law, assuming a porosity of .20 and a hydraulic conductivity of 10^{-3} cm/sec. for glacial till (Fetter 1980). Seepage velocities of 41.4 ft./yr. and 8.8 ft./yr. were estimated for the two components of flow shown in Figure 3. With the available monitoring wells, no east-west component of flow could be ascertained. Flow from the underground depression, as shown by the closed groundwater contours, is thus unknown.

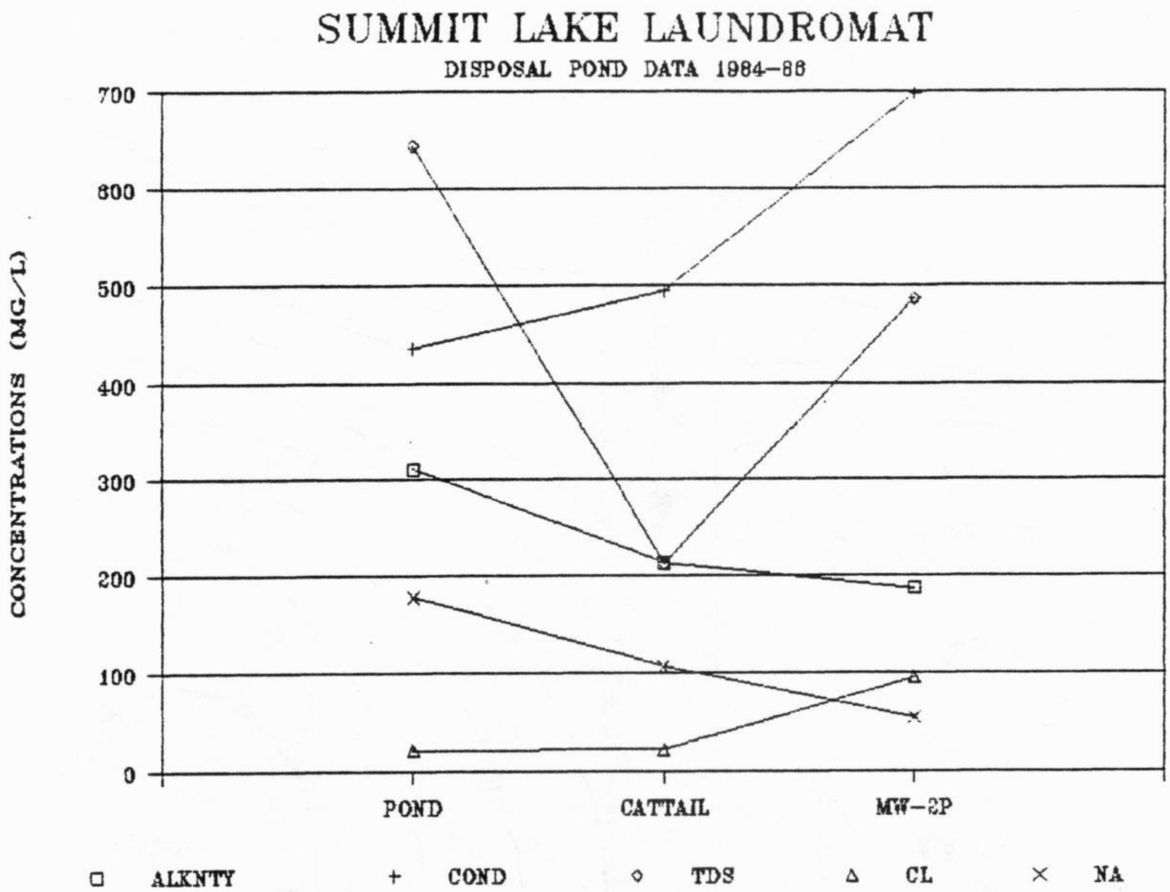
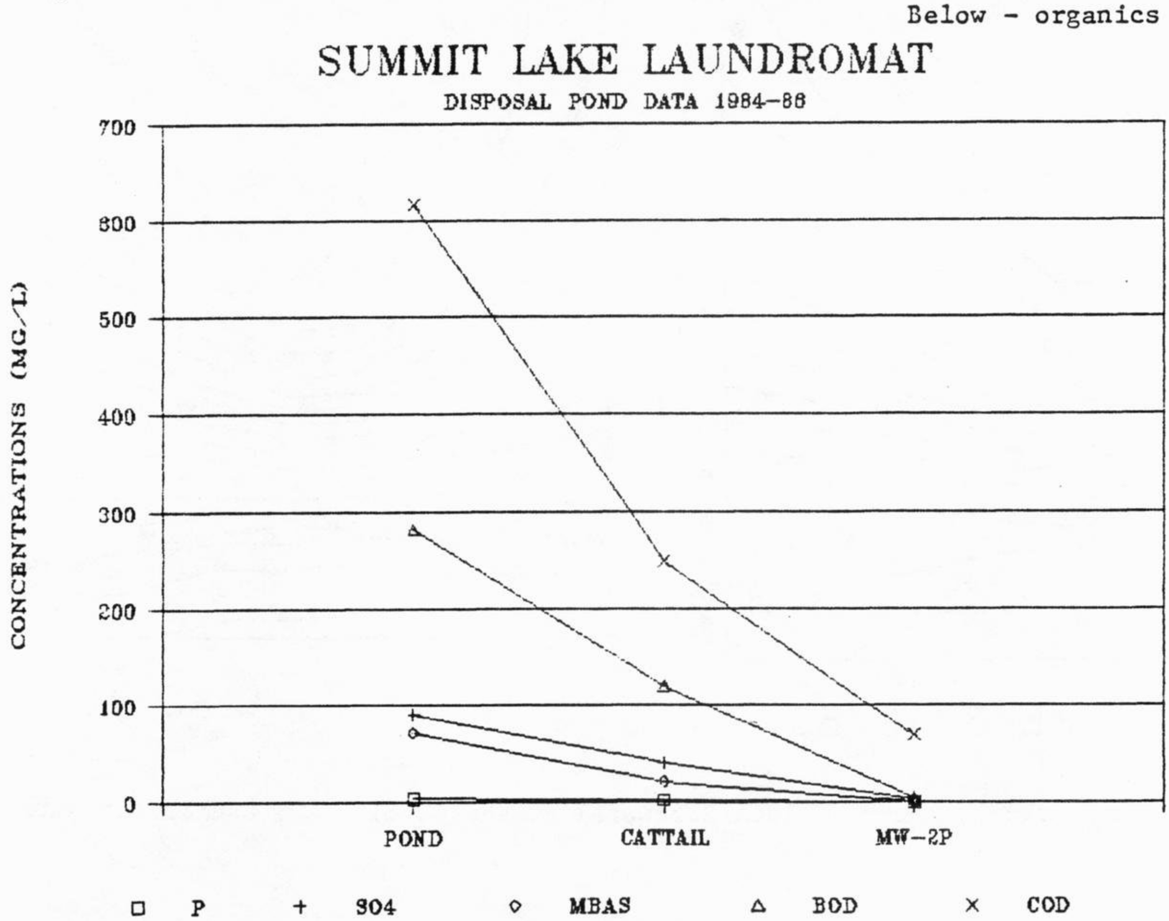


Figure 2. Wastewater assimilation in the disposal pond: Above - inorganics
Below - organics



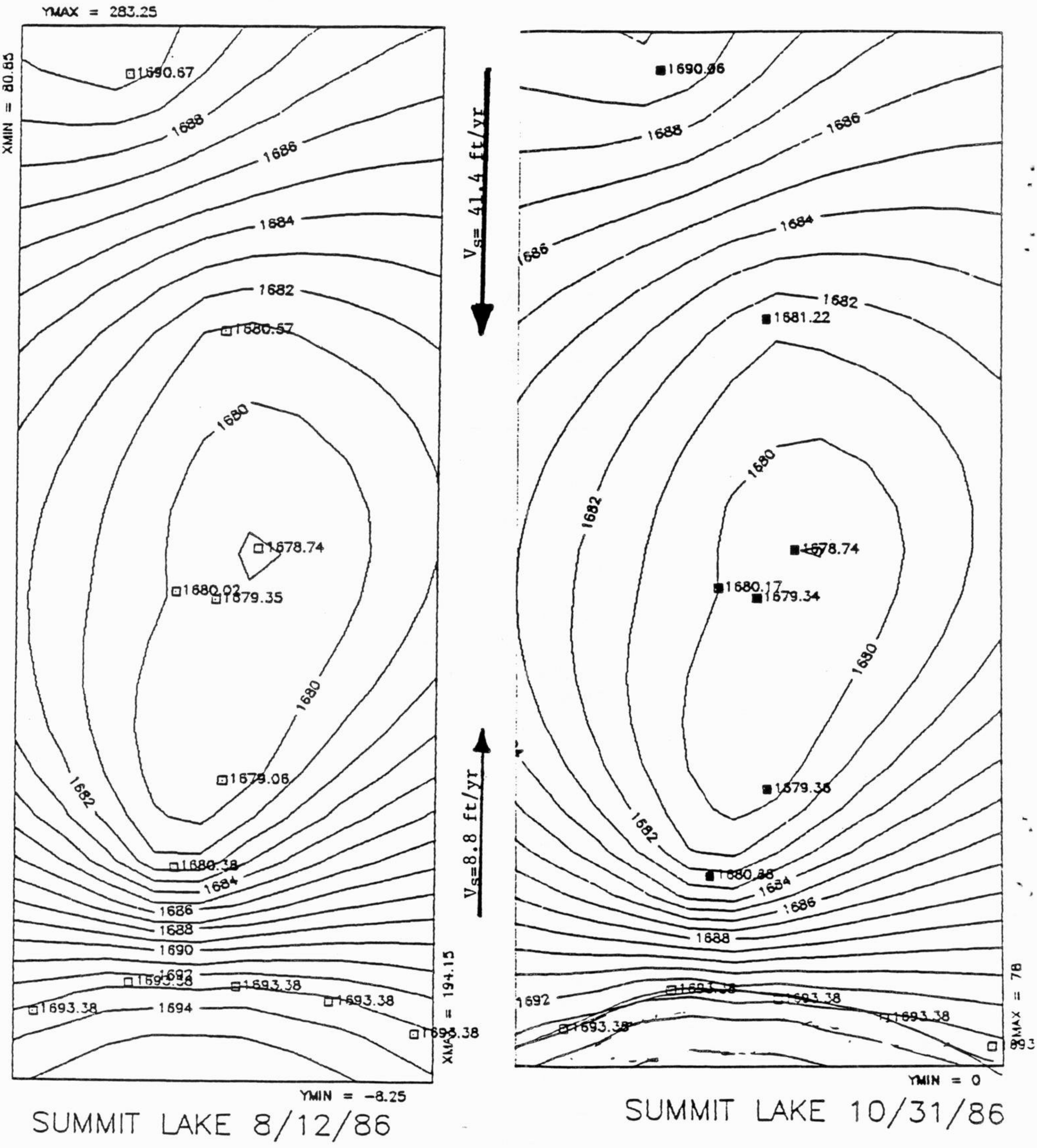


Figure 3. Groundwater contours (Golden Software) at the Summit Lake Laundromat site.

Soil borings in the pond by Proctor and Gamble found the subsurface soils exhibit a high degree of microbial activity under aerobic conditions (Federle and Pastwa 1987). Soil MBAS concentrations decreased by a factor of 100 in the upper ten feet. Less is known of the subsurface activity under anaerobic conditions. The biological activity in and below the pond with the biodegradation of organic compounds and the mobility of nonassimilated inorganic solutes (Fig. 2) is reflected in the monitoring wells (Appendix A).

The groundwater transport of solutes probably occurs with advection and dispersion with a resultant dilution of the solutes. There were no significant changes seen in water quality in the monitoring wells or private wells, with the exception of monitoring Well No. 3. Monitoring Well No. 3 was the only well showing elevated alkalinity, conductivity, sodium, and chlorides, while MBAS, BOD_5, COD, and sulfates were low. Monitoring Well 3 is located fifty feet southwest of the pond (Figure 1) through sand and gravel. Monitoring Well No. 2 is located fifty feet south of the pond but penetrates a clay lense. This well, although close to the pond, showed no significant differences from background groundwater quality. Local groundwater may be protected by the clay lense at this point. The clay lense may impede any downward migration of readily transported solutes. Wastewater in the pond may be moving laterally off the clay lense to the southwest and west, thus offering an explanation for the elevated solute concentrations in Well No. 3.

Based upon Wisconsin's Groundwater legislation, groundwater preventative action limits (PALs) were determined from Wisconsin Administrative Code, Chapter NR 140 Table 1, or calculating them based upon the mean background water quality (MWs 1, 4, 5) plus three standard deviations, or the mean background water quality plus the increase of that parameter listed in Table 3 of the code, whichever was greater (Table 1). Preventative action limits were exceeded only in Well No. 3 for alkalinity, conductance, and total dissolved solids. Statistically significant differences (P=.05) were observed in monitoring Well No. 3 and the background monitoring wells for alkalinity, total dissolved solids, conductivity, sodium, and chloride (Table 2) using the Mann-Whitney Test, a nonparametric statistical method (Unwin and Miner 1985). There were no elevated concentrations of solutes above preventative action limits in the other monitoring wells. There were also no increases in solute concentrations above enforcement standards in the monitoring wells.

Table 1. Preventative Action Limits and Groundwater Standards. NR 140 - Groundwater Quality. Summit Lake (Borne's) Laundromat, Summit Lake, Wisconsin.

	P.A.L.
Chloride	125
MBAS	.25
Sulfate	125
Total Dissolved Solids	250
Alkalinity	136
Hardness	134
Sodium	13
Conductivity	290

Table 2. Groundwater Quality (Mean and Standard Error) in Background and Affected Monitoring Wells, 1984-1986.

	Background MW 1, 4, 5	MW 3
Alkalinity (mg/l as $CaCO_3$)	36 (5.2) n = 12	157 (3.2) n = 8
Conductivity (umhos/cm)	90 (11.2) n = 11	447 (11.9) n = 7
Sodium (mg/l)	2.75 (.33) n = 12	7.88 (.44) n = 8
Chlorides (mg/l)	.72 (.06) n = 12	38.13 (.52) n = 8
Total Dissolved Solids (mg/l)	66 (5.9) n = 11	272 (6.2) n = 7

Groundwater quality impacts witnessed during this study were minimal based on horizontal groundwater movement. Elevated concentrations of inorganic parameters in a monitoring well close to the disposal pond, however, confirm the migration and potential impacts of inorganic solutes. Vertical migration of solutes was not studied and is unknown. While organic constituents of laundry detergents are degraded in the pond and subsurface environment, inorganic solutes are not and are thus capable of being transported. Tolerance for elevated groundwater concentrations of inorganic solutes is predicated on pertinent groundwater quality standards and considerations for public health.

The biologically mediated degradation of the organic fraction of laundry wastewater supports the need for some level of biological wastewater treatment for laundry wastewater. In a rural setting, constructed wetlands, provided suitable soils exist, may be a promising, cost-effective disposal alternative. While wetlands technology does not lend itself to conventional design and naturally occurring parameters are not easily controlled, artificial wetlands may still be a practical and realistic approach to laundry wastewater disposal at remote laundromat locations when transportation of laundry wastewater to a POTW or a landspreading site are cost-prohibitive. Constructed wetlands have demonstrated the ability to treat effluent (U.S. EPA 1984, U.S. EPA 1983). These systems can be constructed with low energy requirements (little pumping required) and minimal operation and maintenance needs. Emergent hydrophytic vegetation become easily established in alkaline environments. The primary function of a constructed wetland treatment system would be for organic and nutrient removal. Further research on constructed wetland systems and the treatment of laundry wastewater is needed. This would be a good research candidate for U.S. EPA sponsored Innovative and Alternative Technology Projects.

Acknowledgements

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APPENDIX A

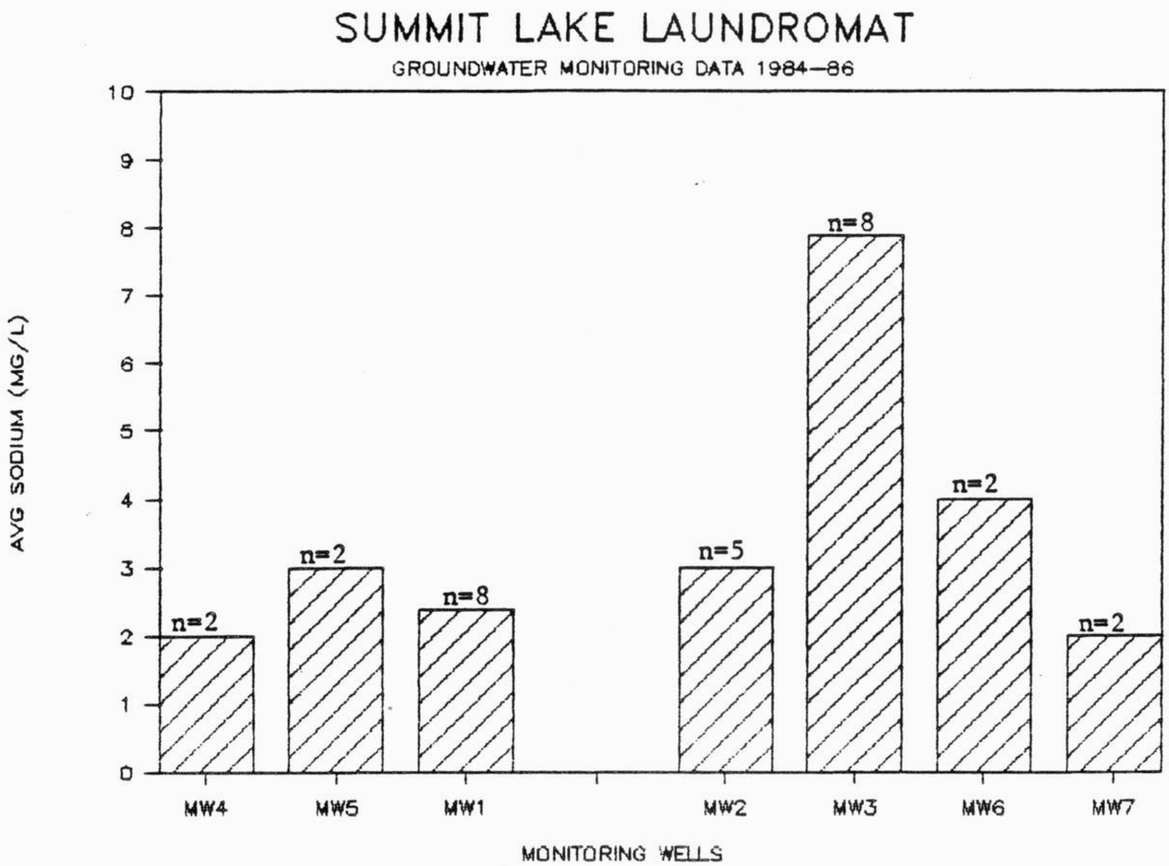
GROUNDWATER MONITORING DATA:

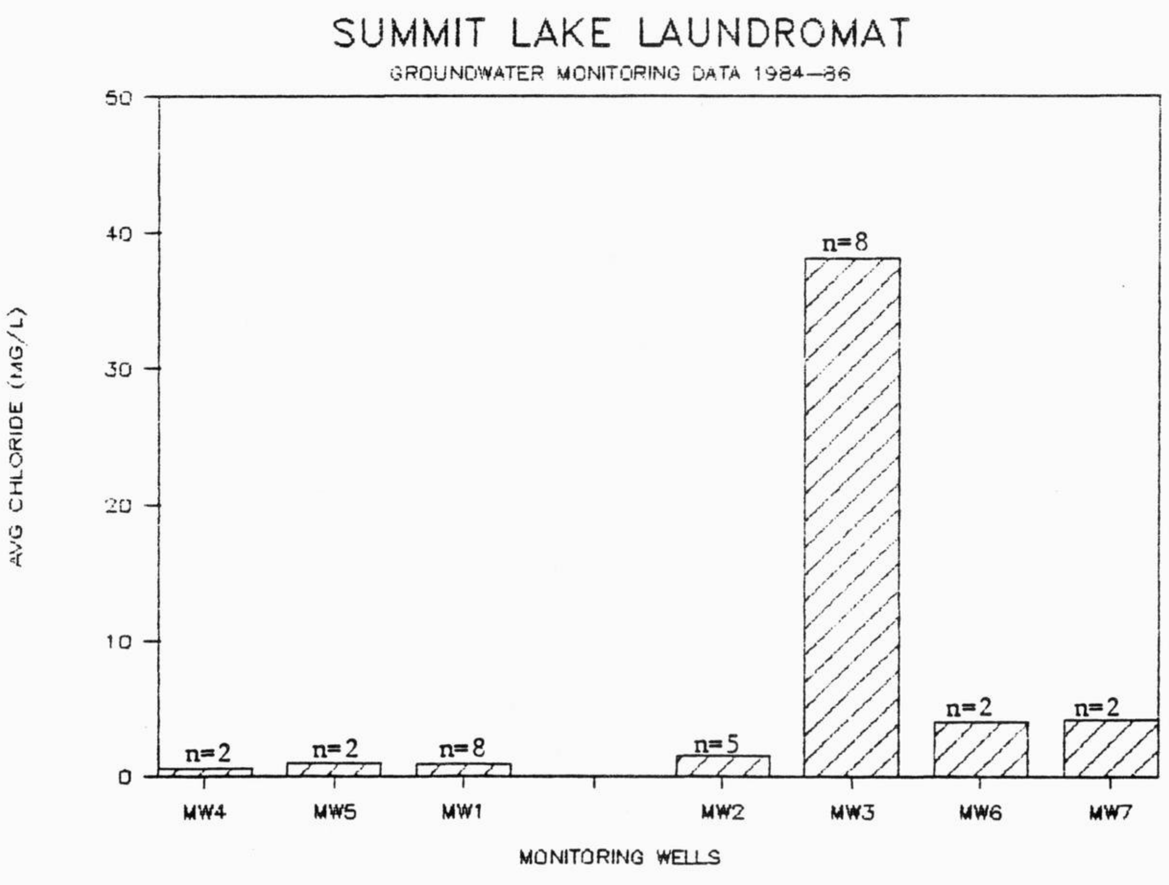
SUMMIT LAKE LAUNDROMAT, SUMMIT LAKE, WISCONSIN

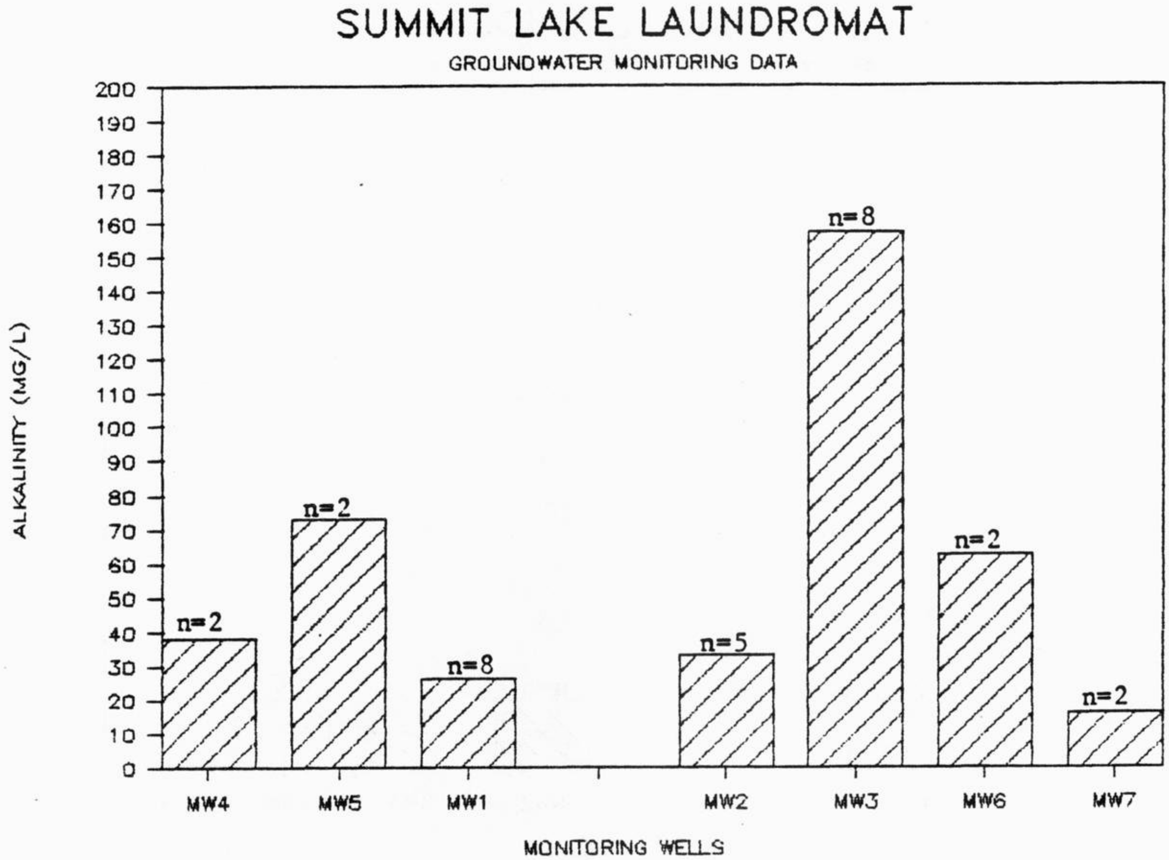
SUMMIT LAKE LAUNDRY - GRNDWTR MW DATA (AVGs)

	ALKNTY	COND	TDS	CL	NA
MW4	38	98	106	0.60	2.00
MW5	73	160	103	0.95	3.00
MW1	26	67	56	0.70	2.38
MW2	33	91	65	1.54	3.00
MW3	157	447	272	38.13	7.88
MW6	62	160	106	4.05	4.00
MW7	16	65	51	4.20	2.00
POND	310	436	644	22	178
CATTAIL	213	495	212	23	107
MW-2P	187	698	487	96	55

	P	SO4	MBAS	BOD	COD
MW4	0.00	9.35	0.00	0	0
MW5	0.01	9.20	0.02	0	0
MW1	0.02	6.84	0.04	1	4
MW2	0.00	8.16	0.02	0	1
MW3	0.01	8.96	0.01	0	1
MW6	0.00	8.55	0.02	0	0
MW7	0.00	5.00	0.00	0	0
POND	4.00	90.43	71	282	617
CATTAIL	1.54	40.00	21	120	249
MW-2P	0.02	2.46	0.04	4	69


SUMMIT LAKE LAUNDROMAT
GROUNDWATER MONITORING DATA 1984—86
AVG SODIUM (MG/L)
0
1
2
3
4
5
6
7
8
9
10
n=2
n=2
n=8
n=5
n=8
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS


SUMMIT LAKE LAUNDROMAT
GROUNDWATER MONITORING DATA 1984—86
AVG CHLORIDE (MG/L)
0
10
20
30
40
50
n=2
n=2
n=8
n=5
n=8
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS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GROUNDWATER MONITORING DATA
ALKALINITY (MG/L)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
n=2
n=2
n=8
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n=2
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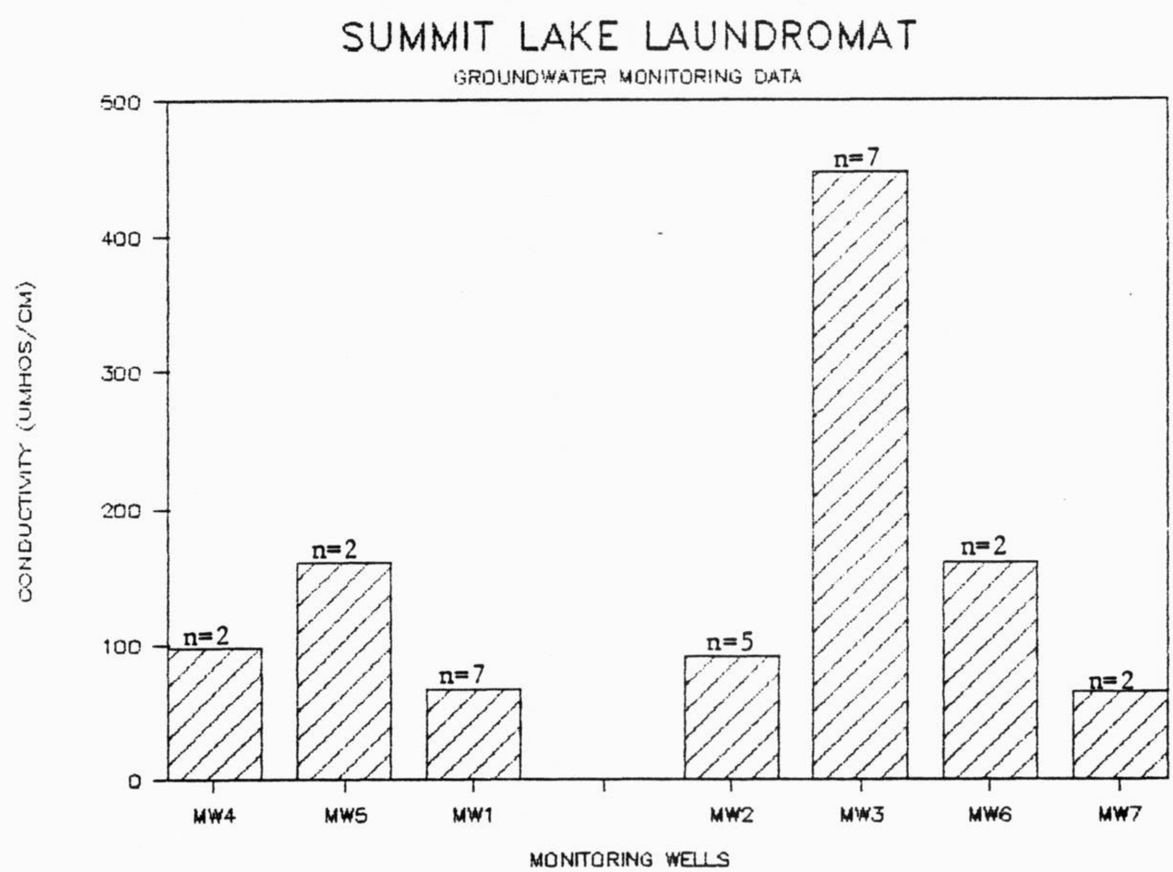
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS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GROUNDWATER MONITORING DATA
CONDUCTIVITY (UMHOS/CM)
0
100
200
300
400
500
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n=2
n=7
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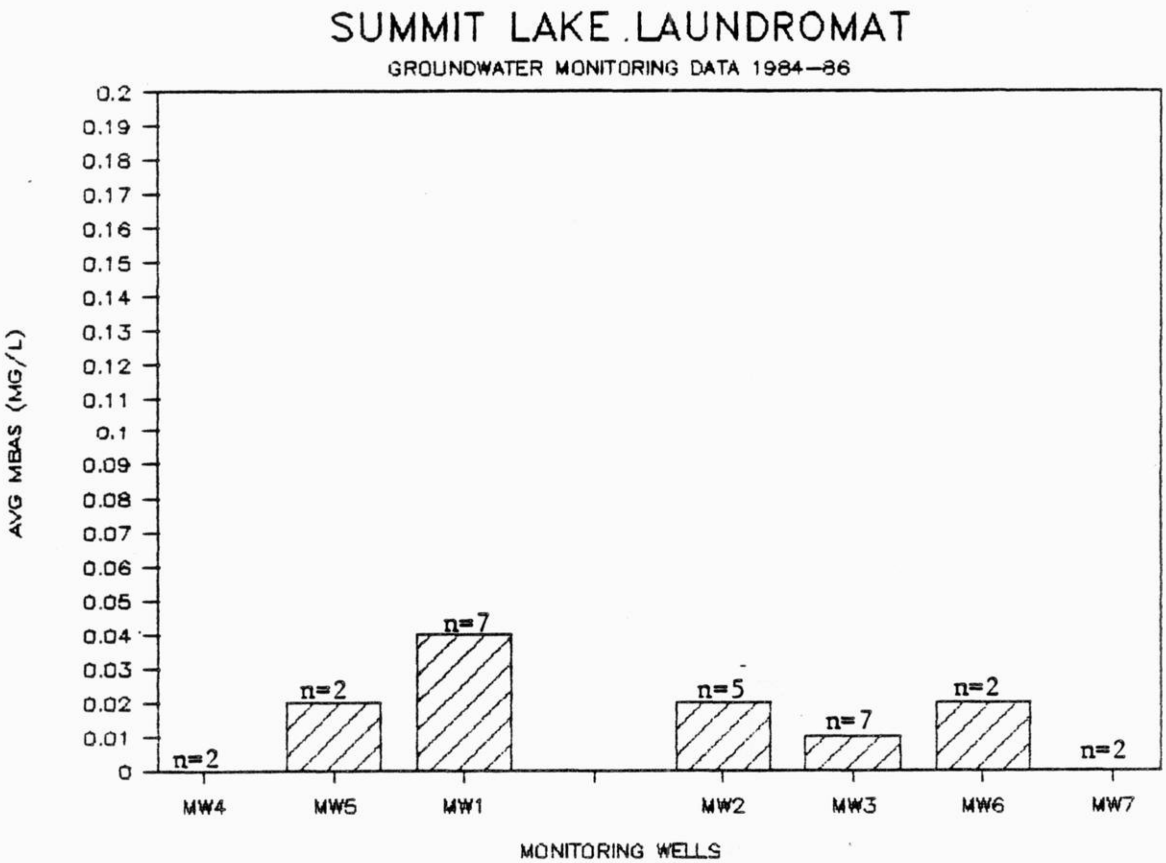
n=7
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS


SUMMIT LAKE LAUNDROMAT
GROUNDWATER MONITORING DATA 1984—86
AVG MBAS (MG/L)
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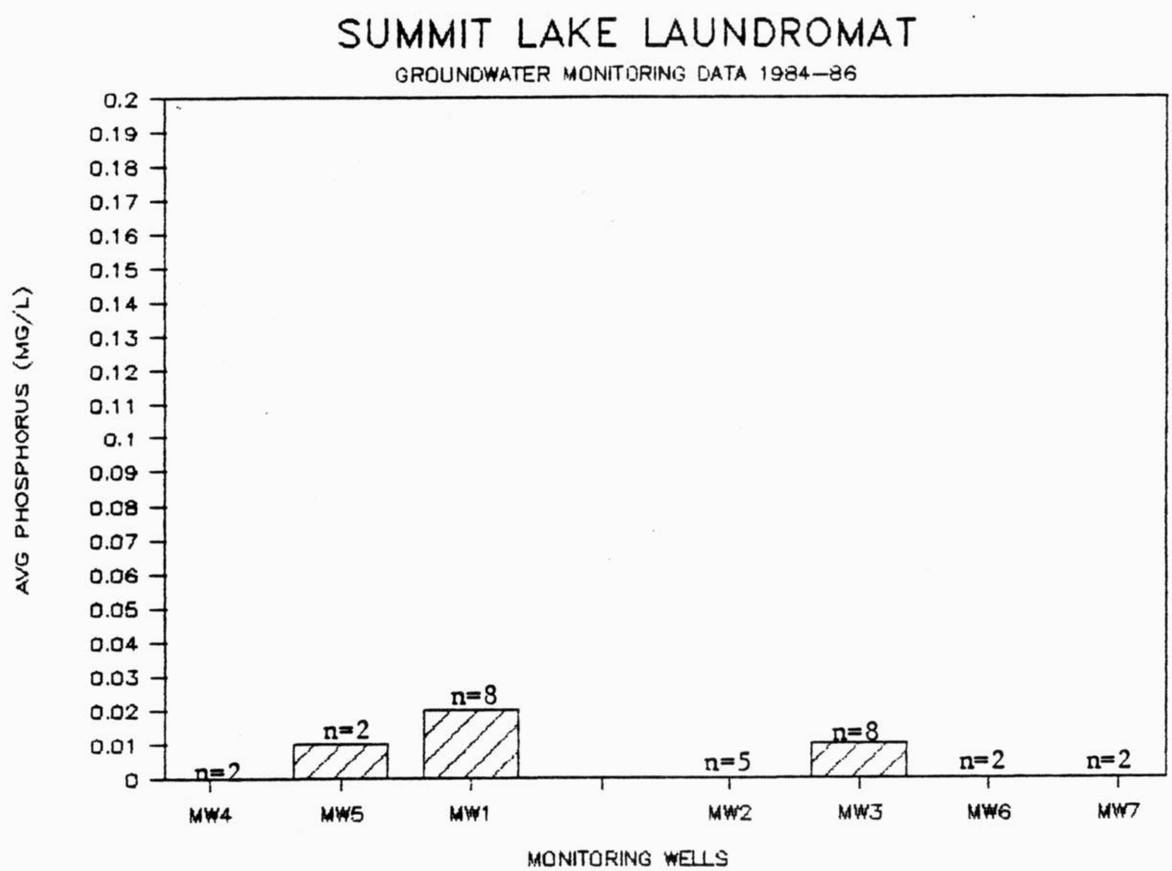
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
n=2
n=2
n=7
n=5
n=7
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS


SUMMIT LAKE LAUNDROMAT
GROUNDWATER MONITORING DATA 1984-86
AVG PHOSPHORUS (MG/L)
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
n=2
n=2
n=8
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MW4
MW5
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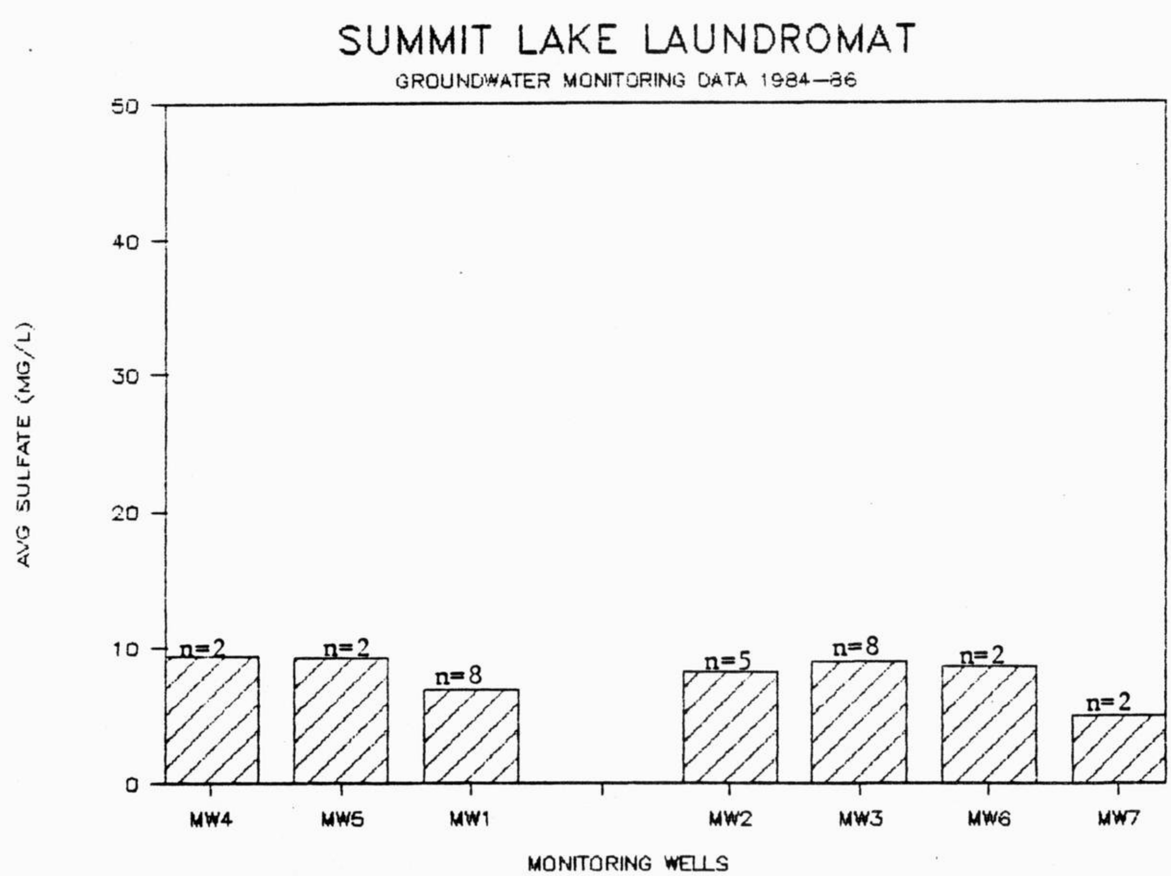
MW2
MW3
MW6
MW7
MONITORING WELLS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GROUNDWATER MONITORING DATA 1984-86
AVG SULFATE (MG/L)
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40
30
20
10
0
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n=2
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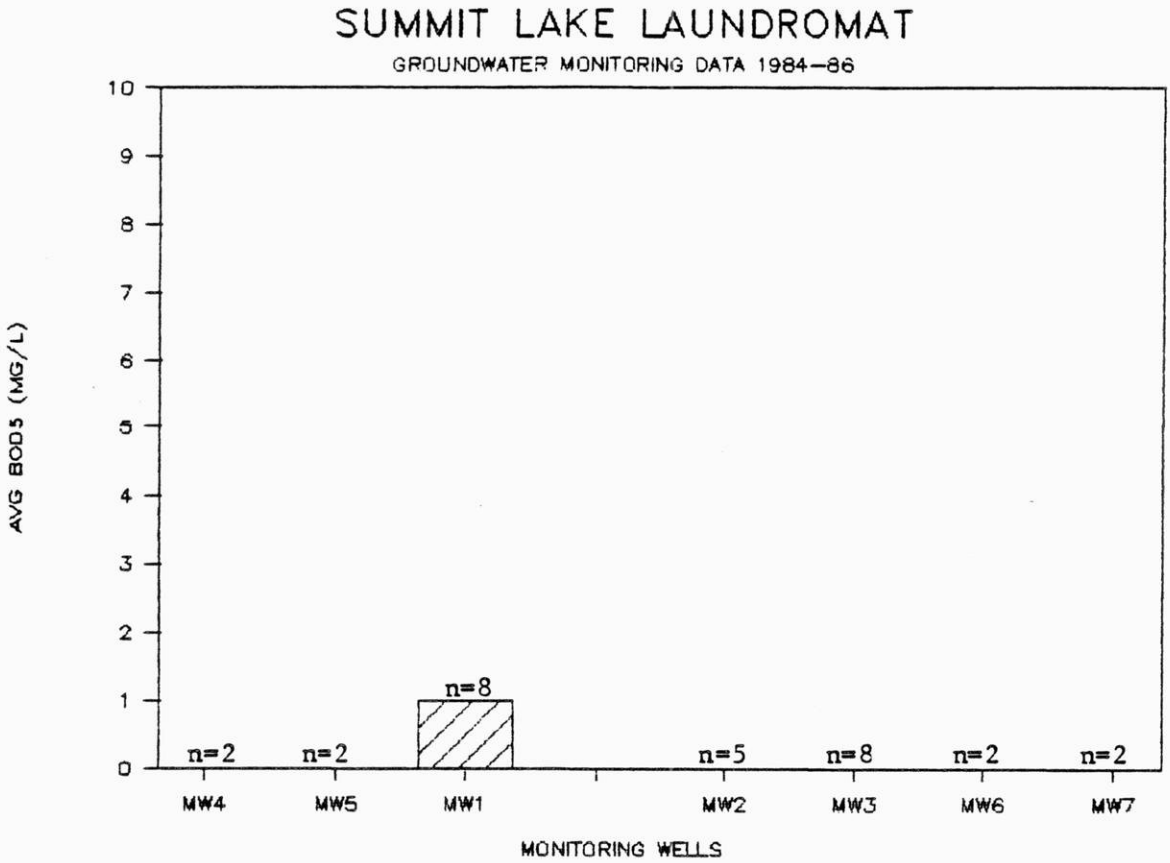
n=5
n=8
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS


SUMMIT LAKE LAUNDROMAT
GROUNDWATER MONITORING DATA 1984-86
AVG BOD5 (MG/L)
0
1
2
3
4
5
6
7
8
9
10
n=2
n=2
n=8
n=5
n=8
n=2
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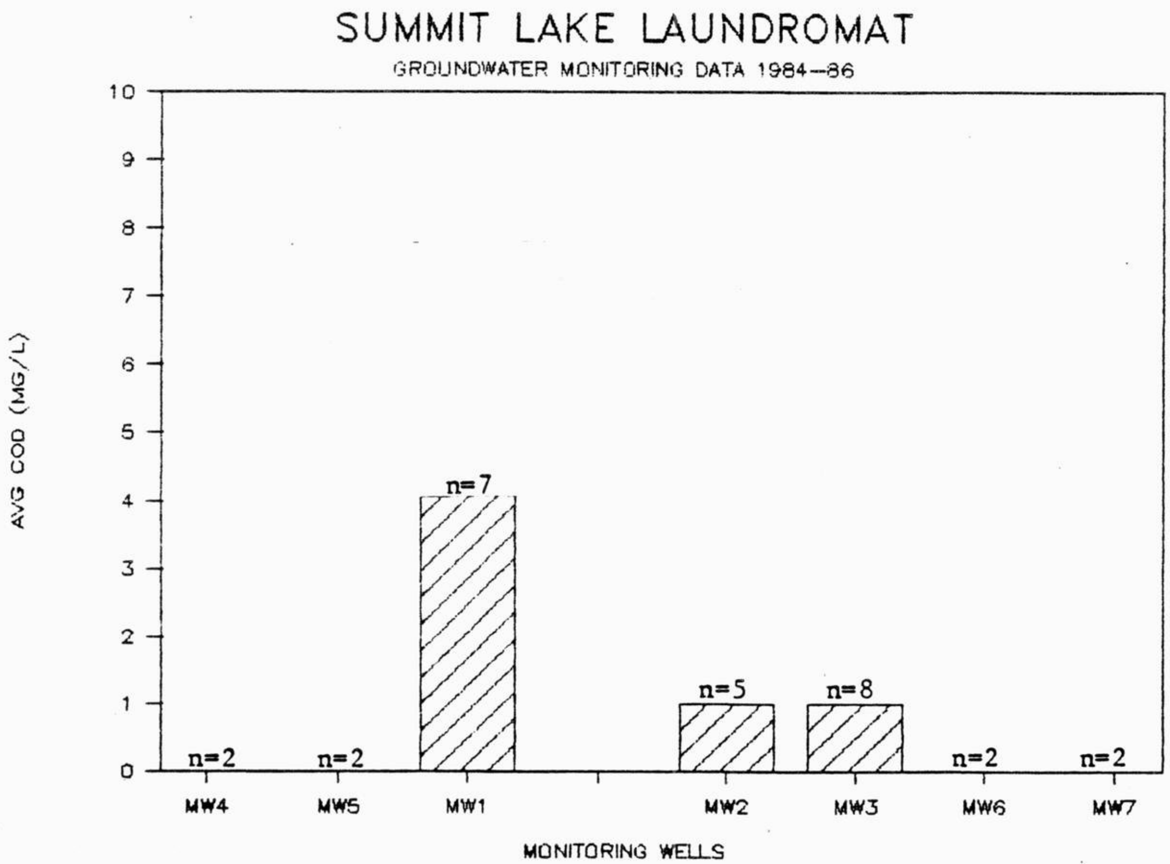
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS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GROUNDWATER MONITORING DATA 1984-86
AVG COD (MG/L)
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4
5
6
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n=2
n=2
n=7
n=5
n=8
n=2
n=2
MW4
MW5
MW1
MW2
MW3
MW6
MW7
MONITORING WELLS

APPENDIX B

MONITORING WELL SAMPLES

MW1

	MBAS	F	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84	<.10	0.02	3	7.2		<3	36	36				7.1
04/30/85	0.08	0.02	3	6.7	8	4	24	28	62	0.9	69	7.0
08/08/85		0.02	2	6.9	7	4	26	29	64	0.9	74	7.0
10/17/85	0.06	0.02	3	6.3	<5	<3	26	27	54	0.7	63	6.4
01/15/86	<.04	0.02	2	6.9	6	<3	26	29	56	0.5	64	7.1
04/16/86	0.05	<.02	2	6.9	<5	<3	26	30	52	0.5	63	6.9
08/13/86	0.08	0.02	2	6.9	<5	<3	22	27	46	0.9	68	6.8
10/22/86	<.04	0.02	2	6.9	7	<3	24	25	58	0.5	69	6.8
AVG	0.04	0.02	2.38	6.84	4.00	1.00	26.25	28.88	56.00	.7	67.14	6.89
STD DEV	0.04	0.01	0.52	0.26	3.78	1.85	4.20	3.27	6.11	.2	4.06	0.23

HW2

	MBAS	F	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
04/30/85												
08/08/85												
10/17/85	<.04	<.02	5	8.5	<5	<3	58	55	94	3.1	150	6.4
01/15/86	0.05	<.02	3	8.4	7	<3	33	36	70	1.4	88	7.4
04/16/86	<.04	<.02	3	8.3	<5	<3	26	27	54	1.3	75	6.7
08/13/86	0.04	<.02	2	7.9	<5	<3	22	25	46	0.8	70	6.4
10/22/86	<.04	<.02	2	7.7	<5	<3	24	25	60	1.1	71	6.6
AVG	0.02	0.00	3.00	8.16	1.40	0.00	32.60	33.60	64.80	1.54	90.80	6.70
STD DEV	0.02	0.00	1.22	0.34	3.13	0.00	14.79	12.80	18.53	0.90	33.86	0.41

MW3

	MBAS	F	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84	<.04	<.02	10	8.7	7	<3	148	196		36		7.4
04/30/85	<.04	0.02	8	8.2	<5	<3	152	194	282	36	410	7.6
08/08/85		<.02	9	8.8	<5	<3	168	227	298	39	480	7.7
10/17/85	<.04	0.02	8	9.4	<5	<3	154	201	262	40	450	7.4
01/15/86	0.06	0.02	8	9.4	<5	<3	166	200	274	39	450	7.8
04/16/86	<.04	<.02	7	9.6	<5	<3	162	200	246	38	460	7.5
08/13/86	0.04	0.02	7	8.8	<5	<3	164	220	276	38	480	7.5
10/22/86	<.04	0.02	6	8.8	<5	<3	144	200	266	39	400	7.1
AVG	0.01	0.01	7.88	8.96	0.88	0.00	157.25	204.75	272.00	38.13	447.14	7.50
STD DEV	0.03	0.01	1.25	0.47	2.47	0.00	8.94	11.96	16.37	1.46	31.47	0.21

MW4

	MBAS	P	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
04/30/85												
08/08/85												
10/17/85												
01/15/86												
04/16/86												
08/13/86	<.04	<.02	2	9.2	<5	<3	38		58	0.6	97	7.0
10/22/86	<.04	<.02	2	9.5	<5	<3	38	43	68	0.6	100	6.7

AVG
STD DEV

MW5	MBAS	F	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
04/30/85												
08/08/85												
10/17/85												
01/15/86												
04/16/86												
08/13/86	0.04	<.02	3	9.3	<5	<3	72	83	98	0.9	160	7.5
10/22/86	<.04	0.02	3	9.1	<5	<3	74	80	108	1.0	160	7.6
AVG												
STD DEV												

MW6

	MBAS	P	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
04/30/85												
08/08/85												
10/17/85												
01/15/86												
04/16/86												
08/13/86	0.04	<.02	4	8.3	<5	<3	62	78	102	4.0	160	7.0
10/22/86	<.04	<.02	4	8.8	<5	<3	62	78	110	4.1	160	7.0
AVG												
STD DEV												

MW7

	MBAS	B	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
01/30/85												
08/08/85												
10/17/85												
01/15/86												
04/16/86												
08/13/86	<.04	<.02	2	5.0	<5	<3	14	20	48	4.9	60	6.5
10/22/86	<.04	<.02	2	5.0	<5	<3	18	23	54	3.5	69	7.0
AVG												
STD DEV												

POND

	MBAS	B	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84	54.00	2.50	160	70	610	190	336	78		30		8.1
04/30/85	78.00	0.96	170	140	460	240	270	68	674	17	820	9.3
08/08/85	83.00	3.00	110	48	1200	600	248	111	568	31	660	7.7
10/17/85	58.00	20.00	240	120	510	220	492	108	994	27	120	9.3
01/15/86	110.00	0.94	200	140	550	300	339	110		15		8.8
04/16/86	23.00	0.74	89	46	230	63	186	41	338	13	460	7.3
08/13/86	89.00	0.74	280	69	760	360	302	98		17	120	9.8
AVG	70.71	4.13	178.43	90.43	617.14	281.86	310.43	87.71	643.50	21.71	436.00	8.61
STD DEV	28.28	7.06	67.90	41.71	302.97	168.11	96.20	26.52	272.53	7.27	315.40	0.93

MW2-P	MBAS	P	NA	SO4	COD	BOD	ALKNTY	HRDNS	TDS	CL	COND	pH
12/20/84												
04/30/85												
08/08/85												
10/17/85	0.05	0.02	58	5.1	74	3	184	170	492	100	680	6.3
01/15/86	0.04	0.03	55	2.6	63	<4	183	181	454	92	640	6.8
04/16/86	0.04	<.02	50	1.4	60	<4	176	110	392	66	550	6.8
08/13/86	0.07	0.02	55	<1.0	77	10	192	150	522	100	820	6.4
10/22/86	<.04	0.02	58	3.2	70	9	198	190	574	120	800	6.2
AVG	0.04	0.02	55.20	2.46	68.80	4.40	186.60	160.20	486.80	95.60	698.00	6.50
STD DEV	0.03	0.01	3.27	1.92	7.19	4.83	8.53	31.78	68.80	19.51	112.78	0.28

APPENDIX C

PRIVATE WELL SAMPLES

Water Quality of Private Wells. Summit Lake, WI

	South Cottages				North	
	Stemmeler 4/23/85	Hunter 8/ 8/85	Jones 8/ 8/85	Reed 8/ 8/85	Corner Cafe 4/30/85	Ranger Station 8/ 8/85
pH (s.u.)	7.5	7.4	7.1	7.9	7.0	8.0
Alkalinity (mg/1)	82	90	66	110	56	126
Hardness (mg/1)	86	168	60	107	58	137
Conductivity (umhos/cm)		210	160	220	120	250
Total Dissolved Solids (mg/1)	114	134	108	136	96	150
Sodium (mg/1)	3	3	3	4	3	7
Chloride (mg/1)	5.2	6.1	2.1	1.7	1.3	.7
Sulfates (mg/1)	5.4	5.6	7.3	1.2	7.7	2.0
Phosphate (mg/1)	.06	.02	.02	.16	.03	.30
BOD_5 (mg/1)	3	3	3	3	3	3
COD (mg/1)	5	5	5	5	5	5
MBAS (mg/1)	.04	.04	.04	.04	.04	.04