TECHNICAL PUBLICATION SJ 79-4
PART 2 - SUPPLEMENTAL DATA

SALINE CONTAMINATION OF A LIMESTONE AQUIFER BY CONNATE INTRUSION IN AGRICULTURAL AREAS OF ST. JOHNS, PUTNAM, AND FLAGLER COUNTIES, NORTHEAST FLORIDA

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INTRODUCTION

A ground water investigation of the agricultural areas of St. Johns, Putnam, and Flagler counties was conducted by the St. Johns River Water Management District. The results of that project can be found in Technical Report No. 2, "Saline Contamination of a Limestone Aquifer in Agricultural Areas of St. Johns, Putnam, and Flagler Counties, Northeast Florida", St. Johns River Water Management District, July 1979.

Contained herein are the data, in tabular form, collected during the duration of the project which were used for hydrogeologic interpretation contained in Technical Report No. 2. Also presented in greater detail are several expanded sections of the Technical Report for those readers who may desire further clarification.

WELL DATA

WELL DATA

Well Data contained in this section are presented as two separate data files. Within the Master Well Data File (Table 1) is the information pertaining to the location and physical characteristics of various wells used for monitoring purposes. Contained within the Well Data File (Table 2) are the water level and chloride values collected from those sample wells (Figure 1) listed in the Master Well Data File.

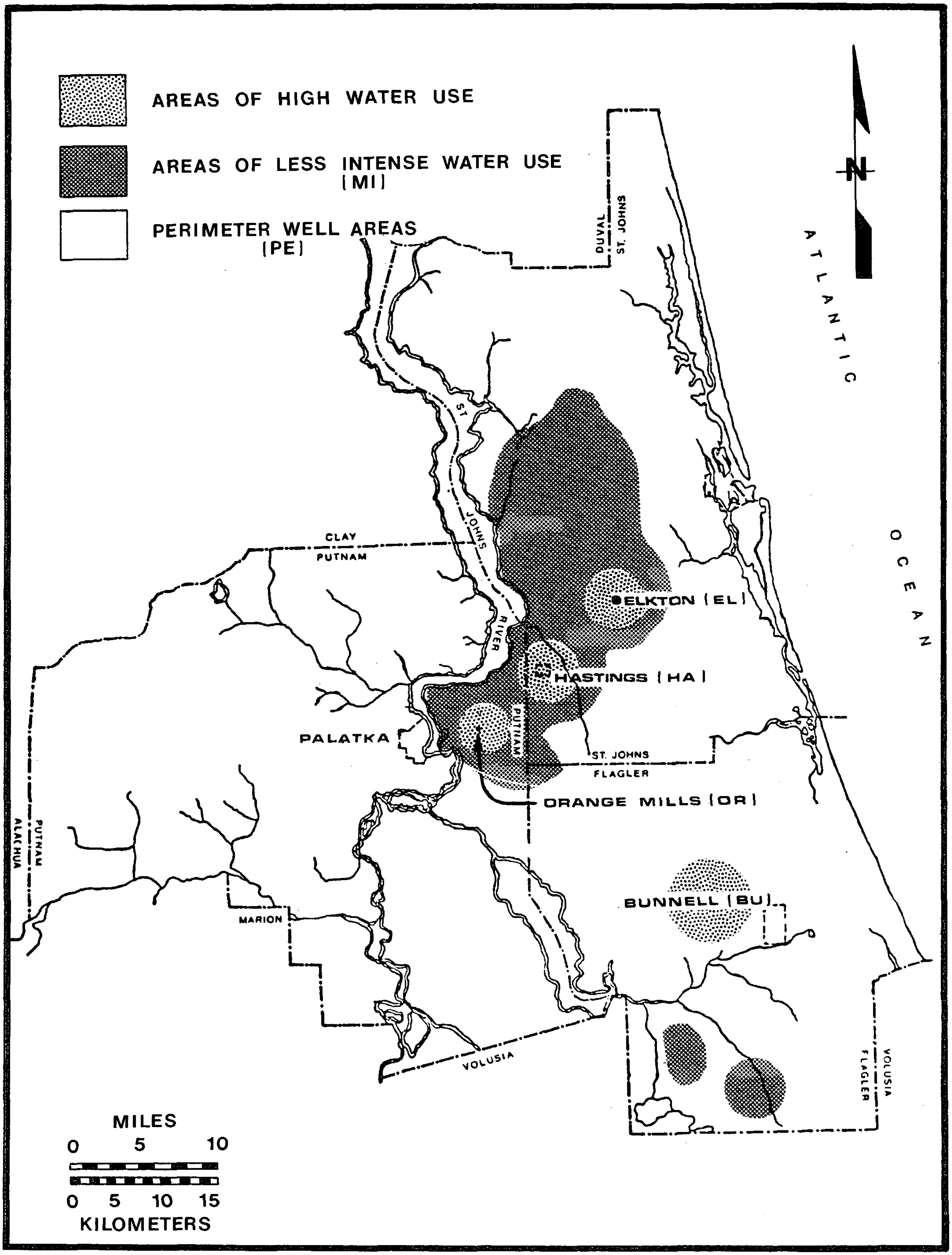


FIGURE 1. -- Generalized Location of Observation Wells Sampled as Referenced in Data Files

TABLE 1 - WELL MASTER FILE

CONE	LOC #	CNTY.	WELL DIAM	WELL DEPTH	PENET- RATION	LATITUDE			LONGITUDE		
						DG	MN	SC	DEG	MN	SC
PE	2	19	4.0	494	220	29	53	53	081	38	19
PE	3	19	3.0	475	188	29	58	47	081	38	06
PE	4	19	3.0	365	65	30	00	48	081	14	43
PE	5	19	3.0	365	65	30	00	48	081	41	43
BU	1	35	6.0	480	312	29	29	42	081	24	36
BU	11	35	6.0	480	312	29	29	18	081	24	21
BU	18	35	4.0	-	-	29	29	07	081	23	34
BU	66	35	6.0	198	101	29	25	23	081	23	47
BU	88	35	4.0	159	5	29	28	20	081	22	10
BU	96	35	4.0	141	76	29	22	26	081	20	56
BU	101	35	6.0	113	5	29	25	38	081	22	02
BU	114	35	8.0	375	229	29	29	08	081	21	51
BU	120	35	6.5	307	142	29	29	20	081	23	27
BU	126	35	6.0	358	243	29	26	47	081	18	20
BU	133	35	6.0	480	312	29	29	05	081	23	58
MI	107	35	4.0	168	-	29	17	20	081	19	44
MI	108	35	6.0	325	-	29	19	02	081	18	56
MI	117	35	6.0	-	-	29	29	01	081	16	28
PE	83	35	6.0	412	246	29	37	16	081	29	26
PE	84	35	4.0	125	5	29	35	52	081	27	52
PE	87	35	4.0	417	-	29	27	50	081	15	20
PE	95	35	6.0	300	175	29	30	18	081	29	30
PE	97	35	4.0	167	122	29	19	55	081	20	09
PE	115	35	6.0	613	463	29	37	29	081	22	12
PE	128	35	8.0	250	-	29	29	47	081	17	43
PE	130	35	12.0	225	135	29	25	52	081	12	55
PE	134	35	2.0	152	18	29	33	38	081	10	05
MI	10	107	3.0	115	5	29	45	15	081	31	40
MI	26	107	4.0	-	-	29	44	30	081	31	50
MI	53	107	6.0	-	-	29	42	34	081	31	46
MI	76	107	4.0	235	72	29	42	55	081	32	30
MI	92	107	4.0	-	-	29	43	50	081	32	20
MI	193	107	6.0	397	240	29	35	49	081	32	12
MI	255	107	8.0	-	-	29	22	38	081	28	24
OR	57	107	6.0	150	5	29	41	55	081	33	18
OR	58	107	4.0	356	208	29	41	45	081	33	30
OR	60	107	3.0	300	152	29	41	15	081	35	00
OR	68	107	4.0	408	151	29	41	30	081	35	40
OR	69	107	4.0	-	-	29	41	14	081	33	29
OR	77	107	4.0	257	146	29	40	55	081	35	45
OR	78	107	4.0	163	38	29	40	14	081	33	12
OR	90	107	6.0	453	331	29	41	05	081	33	35
OR	95	107	6.0	460	345	29	40	26	081	35	48
OR	100	107	4.0	236	94	29	40	45	081	35	15
OR	107	107	4.0	400	286	29	40	22	081	34	13
OR	172	107	6.0	542	420	29	39	32	081	34	28
OR	178	107	4.0	392	259	29	39	42	081	36	11
OR	186	107	4.0	-	-	29	40	12	081	36	50
OR	190	107	13.0	1656	1048	29	37	38	081	35	16
OR	218	107	4.0	-	-	29	41	15	081	36	45
OR	221	107	4.0	340	254	29	40	00	081	34	00
OR	229	107	3.0	-	-	29	39	30	081	34	59
OR	230	107	4.0	171	41	29	39	18	081	34	42
OR	311	107	4.0	-	-	29	40	21	081	34	58
OR	333	107	6.0	411	286	29	41	35	081	33	45

TABLE 1 CONTD.

CONE	LOC	CNTY.	WELL	WELL	PENET-	LATITUDE			LONGITUDE		
	#		DIAM	DEPTH	RATION	DG	MN	SC	DEG	MN	SC
PE	203	107	-	-	-	29	35	49	081	31	40
PE	238	107	10.0	445	360	29	28	07	081	33	08
PE	242	107	4.0	135	40	29	26	06	081	31	25
PE	243	107	2.5	210	125	29	34	41	081	37	34
PE	270	107	6.0	124	22	29	25	28	081	38	35
PE	271	107	3.5	185	100	29	22	19	081	37	11
PE	273	107	6.0	158	108	29	28	34	081	40	25
PE	280	107	4.0	295	108	29	32	24	081	42	41
PE	284	107	4.0	-	-	29	34	19	081	41	57
PE	290	107	4.0	234	50	29	35	35	081	46	00
PE	298	107	4.0	-	-	29	40	34	081	43	10
PE	306	107	8.0	189	81	29	33	00	081	52	39
PE	315	107	6.0	267	57	29	45	40	081	38	33
PE	317	107	4.0	-	-	29	27	32	081	30	48
EL	267	109	4.0	304	124	29	47	22	081	26	49
EL	286	109	4.0	401	246	29	47	27	081	27	52
EL	289	109	6.0	310	109	29	47	51	081	30	02
EL	317	109	4.0	275	95	29	47	02	081	26	32
EL	388	109	6.0	389	175	29	47	57	081	26	07
HA	31	109	4.0	450	289	29	42	53	081	29	49
HA	76	109	8.0	400	198	29	43	34	081	27	08
HA	99	109	6.0	505	328	29	41	07	081	27	13
HA	140	109	4.0	315	138	29	40	28	081	26	28
HA	149	109	4.0	350	185	29	40	28	081	28	27
HA	152	109	4.0	448	339	29	40	03	081	30	46
HA	154	109	4.0	295	133	29	39	55	081	28	00
HA	168	109	4.0	297	120	29	39	47	081	28	45
HA	169	109	4.0	202	45	29	42	38	081	30	37
HA	190	109	4.0	265	90	29	41	43	081	28	58
HA	194	109	4.0	440	256	29	41	58	081	29	28
HA	195	109	4.0	440	255	29	41	58	081	29	22
HA	200	109	4.0	385	201	29	41	59	081	29	08
HA	203	109	4.0	205	68	29	39	07	081	29	42
HA	210	109	4.0	215	102	29	39	51	081	30	10
HA	218	109	4.0	300	136	29	43	03	081	29	23
HA	226	109	4.0	497	322	29	40	53	081	29	27
HA	263	109	6.0	541	347	29	41	28	081	29	13
HA	264	109	6.0	420	231	29	41	19	081	29	11
HA	378	109	4.0	291	121	29	39	43	081	28	43
HA	379	109	4.0	260	125	29	40	59	081	30	46
HA	466	109	6.0	331	207	29	40	59	081	30	35
MI	46	109	6.0	300	49	29	58	03	081	29	14
MI	50	109	4.0	235	122	29	41	34	081	31	24
MI	52	109	6.0	300	53	29	51	25	081	30	45
MI	61	109	4.0	320	79	29	54	52	081	31	42
MI	111	109	4.0	371	130	29	50	41	081	29	47
MI	112	109	6.0	350	170	29	44	07	081	28	37
MI	114	109	4.0	300	140	29	43	16	081	31	15
MI	133	109	6.0	450	213	29	50	39	081	32	54
MI	215	109	6.0	400	132	29	49	52	081	29	14
MI	290	109	4.0	213	12	29	46	47	081	29	04
MI	371	109	6.0	174	19	29	40	40	081	25	56
MI	389	109	4.0	301	143	29	46	12	081	25	34
MI	395	109	6.0	500	210	29	50	08	081	32	08
PE	20	109	4.0	237	5	29	54	55	081	35	35

TABLE 1 CONTD.

CONE	LOC #	CNTY.	WELL DIAM	WELL DEPTH	PENET- RATION	LATITUDE DG	LATITUDE MN	LATITUDE SC	LONGITUDE DEG	LONGITUDE MN	LONGITUDE SC
PE	119	109	4.0	217	5	29	54	42	081	27	22
PE	168	109	4.0	200	5	29	49	27	081	33	12
PE	401	109	4.0	559	302	29	56	45	081	26	58
PE	406	109	6.0	400	82	29	58	52	081	33	30
PE	412	109	4.0	350	90	29	57	13	081	20	34
PE	413	109	6.0	198	3	29	55	02	081	17	54
PE	415	109	4.0	253	73	29	53	33	081	19	14
PE	416	109	6.0	325	70	29	59	41	081	22	19
PE	418	109	3.0	360	10	30	00	33	081	37	10
PE	422	109	2.0	364	50	30	03	54	081	30	12
PE	427	109	3.0	600	199	30	03	22	081	34	28
PE	428	109	4.0	300	124	29	52	29	081	17	21
PE	429	109	4.0	300	70	29	50	47	081	19	30
PE	432	109	6.0	210	12	29	46	02	081	15	19
PE	433	109	6.0	450	180	30	03	17	081	22	40
PE	434	109	6.0	336	2	30	05	55	081	29	06
PE	435	109	4.0	258	17	30	00	48	081	23	34
PE	436	109	3.0	580	145	30	07	17	081	38	10
PE	438	109	4.0	350	96	30	00	36	081	21	35
PE	458	109	-	-	-	29	58	49	081	26	14
PE	1	127	6.0	-	-	29	19	05	081	25	10

131 ENTRIES FOUND

ABBREVIATION LISTING

BU = IRRIGATION WELLS LOCATED IN BUNNELL AREA
EL = IRRIGATION WELLS LOCATED IN ELKTON AREA
HA = IRRIGATION WELLS LOCATED IN HASTINGS AREA
MI = MISCELLANEOUS IRRIGATION WELLS OUTSIDE AREAS OF INTENSIVE AGRICULTURE
OR = IRRIGATION WELLS LOCATED IN ORANGE MILLS AREA
PE = PERIMETER WELLS

CNTY = COUNTY
19 = CLAY COUNTY
35 = FLAGLER COUNTY
107 = PUTNAM COUNTY
109 = ST. JOHNS COUNTY
127 = VOLUSIA COUNTY

TABLE 2 - WELL DATA FILE

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
BU	1	75-03-10	-	2950	1550	23.0	640
BU	11	75-03-10	-	3050	1625	23.0	700
BU	18	76-03-03	8.45	-	-	-	-
BU	18	76-04-19	6.71	-	-	-	-
BU	18	76-05-31	8.82	-	-	-	-
BU	66	75-03-12	10.65	3100	1650	22.0	890
BU	66	75-07-03	10.56	3000	1600	22.0	800
BU	66	75-09-10	11.49	3100	1550	22.2	820
BU	66	75-12-03	11.37	3000	1500	22.0	790
BU	66	76-01-14	10.84	2900	1450	23.0	810
BU	66	76-03-03	9.57	2500	1250	22.0	780
BU	66	76-04-19	7.94	2400	1200	23.0	810
BU	66	76-06-14	10.30	3000	1600	23.0	780
BU	66	76-09-27	11.88	2700	1400	23.0	770
BU	88	75-03-11	14.41	-	-	-	-
BU	88	75-05-15	13.26	-	-	-	-
BU	88	75-09-10	15.38	-	-	-	-
BU	88	75-12-03	16.38	-	-	-	-
BU	88	76-03-03	13.60	-	-	-	-
BU	88	76-04-19	12.43	-	-	-	-
BU	88	76-06-14	14.84	-	-	-	-
BU	96	75-03-12	7.45	3050	1650	22.0	810
BU	96	75-07-03	7.76	3000	1600	22.0	805
BU	96	75-09-10	8.65	3000	1500	23.5	760
BU	101	75-03-12	9.71	-	-	-	-
BU	101	75-07-03	9.83	3000	1600	22.0	785
BU	101	75-09-10	10.85	2800	1400	22.8	760
BU	101	75-12-03	10.88	2700	1400	22.0	765
BU	101	76-01-14	10.18	2600	1350	23.0	780
BU	101	76-03-03	8.75	2500	1250	22.0	790
BU	101	76-04-19	7.46	2000	1000	22.0	780
BU	101	76-06-14	9.60	3000	1600	23.0	770
BU	101	76-09-29	11.17	2700	1400	23.0	750
BU	114	75-03-10	7.30	-	-	-	-
BU	114	75-07-02	10.40	900	450	22.0	115
BU	114	75-09-10	11.02	-	-	-	-
BU	120	75-03-10	7.05	-	-	-	-
BU	120	75-07-02	8.66	3000	1600	23.0	880
BU	120	75-09-10	9.55	3000	1600	23.8	880
BU	120	75-12-03	9.71	3000	1600	23.5	820
BU	120	76-01-14	9.27	2900	1500	24.0	870
BU	126	75-03-11	7.51	4500	2450	23.0	1280
BU	126	75-07-02	6.90	3100	1650	22.0	860
BU	126	75-09-10	8.35	2900	1450	22.8	825
BU	126	75-12-03	8.92	2900	1450	22.0	860
BU	126	76-01-14	5.35	2700	1400	22.5	850
BU	126	76-03-03	7.02	2400	1200	22.0	840
BU	126	76-04-19	6.35	2500	1250	23.0	1050
BU	126	76-05-31	7.28	2400	1200	23.0	820
BU	126	76-09-29	8.90	2000	1000	22.5	840
BU	133	75-03-10	12.45	-	-	-	-
BU	133	75-09-10	13.27	3000	1600	23.0	780
BU	133	75-12-03	15.20	2800	1450	22.5	800
BU	133	76-01-14	14.76	2500	1300	23.5	770
BU	133	76-03-03	12.68	-	-	-	-

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
BU	133	76-06-14	13.74	2500	1250	24.0	780
BU	133	76-09-29	15.53	2100	1050	23.5	540
EL	267	75-03-10	18.65	2270	1100	23.0	230
EL	267	75-07-02	24.29	725	350	22.0	106
EL	267	75-09-09	26.04	1600	800	23.5	165
EL	267	76-02-25	18.13	—	—	—	—
EL	267	76-04-13	11.70	—	—	—	—
EL	267	76-05-26	22.16	1900	950	23.0	210
EL	267	76-09-27	25.94	1900	950	23.0	210
EL	286	75-03-10	22.06	2230	1100	23.0	190
EL	286	75-07-02	25.50	1620	800	23.0	204
EL	286	75-09-09	26.13	2000	1000	23.2	180
EL	286	75-11-25	25.34	2000	1000	22.5	185
EL	286	76-01-13	26.25	2000	1000	23.5	190
EL	289	75-03-11	19.71	3250	1600	22.5	510
EL	289	75-07-02	23.60	3020	1500	23.0	500
EL	289	75-09-09	24.70	3100	1550	23.8	470
EL	317	76-04-13	10.70	—	—	—	—
EL	317	76-05-26	22.34	—	—	—	—
EL	317	76-09-27	25.76	—	—	—	—
EL	388	75-03-10	20.35	1800	900	23.5	170
EL	388	75-07-02	22.45	710	350	22.0	86
EL	388	75-09-09	24.74	1600	800	23.8	163
EL	388	75-11-25	24.53	1550	800	23.0	169
EL	388	76-01-08	24.44	1550	800	23.0	190
HA	31	75-03-10	21.40	2180	1000	22.5	275
HA	31	75-06-25	15.70	2050	1000	22.5	274
HA	31	75-09-04	17.00	1800	900	23.0	270
HA	31	75-11-25	15.00	2000	1000	21.5	295
HA	31	76-01-13	16.00	2000	1000	23.5	265
HA	31	76-02-25	15.10	1800	900	24.5	280
HA	31	76-04-13	9.20	2000	1000	24.5	310
HA	31	76-05-25	13.10	2000	1000	22.5	290
HA	31	76-09-22	—	2000	1000	23.0	280
HA	76	75-03-10	14.73	—	—	—	—
HA	76	75-09-08	20.82	2100	1050	23.5	300
HA	76	75-11-26	18.98	2100	1050	23.0	302
HA	76	76-01-08	19.76	2100	1050	23.7	320
HA	76	76-03-03	8.65	—	—	—	—
HA	76	76-04-05	5.83	—	—	—	—
HA	76	76-05-25	16.68	1100	550	23.0	170
HA	76	76-09-27	20.64	2220	1110	21.0	300
HA	99	75-03-10	13.46	2300	1150	22.0	480
HA	99	75-06-25	15.84	2340	1100	23.0	198
HA	99	76-05-25	13.45	2500	1250	24.0	520
HA	140	75-03-10	11.28	2250	1000	23.0	380
HA	140	75-09-08	17.90	1900	950	23.5	390
HA	140	76-05-25	16.00	900	450	22.5	150
HA	149	75-03-11	9.65	2800	1400	23.5	610
HA	149	75-06-25	13.40	3100	1700	24.0	660
HA	149	75-09-05	15.50	2300	1150	23.5	410
HA	149	76-05-24	13.20	2700	1350	24.0	570
HA	152	75-03-13	7.36	2000	1000	24.0	305
HA	152	75-06-26	14.67	1140	600	23.0	182
HA	152	75-09-08	16.02	1800	900	24.5	260

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
HA	152	76-05-19	12.00	1600	800	24.0	290
HA	154	75-03-11	11.30	4000	2000	23.0	870
HA	154	75-09-05	14.70	2900	1450	24.0	605
HA	154	76-05-24	11.80	3300	1650	23.0	780
HA	168	75-09-04	17.29	2700	1350	23.0	610
HA	168	76-05-24	14.35	-	-	-	-
HA	169	75-03-13	11.20	1200	600	20.5	220
HA	169	75-06-25	19.00	1570	750	22.0	176
HA	169	75-09-04	19.40	1600	800	22.0	165
HA	169	76-05-19	14.30	1600	800	22.5	150
HA	190	75-03-11	-	2400	1200	23.8	365
HA	190	75-06-25	-	2600	1250	23.0	430
HA	190	75-09-04	17.10	2300	1150	23.2	370
HA	190	75-11-23	-	2400	1200	23.5	380
HA	190	76-01-14	15.10	2600	1300	24.0	380
HA	190	76-05-24	-	2600	1300	24.0	450
HA	194	75-11-24	-	2400	1200	23.5	395
HA	194	76-01-13	-	2500	1250	23.5	430
HA	194	76-02-25	-	2000	1000	24.0	430
HA	194	76-05-26	11.50	1800	900	23.0	420
HA	195	75-03-12	11.35	5200	3200	22.5	1520
HA	195	75-06-25	15.50	3390	1650	23.5	760
HA	195	75-09-04	16.90	2800	1400	22.5	600
HA	200	75-11-24	14.90	3000	1550	23.0	720
HA	200	76-01-13	14.00	3100	1600	23.0	700
HA	200	76-02-25	-	3500	1900	24.0	1340
HA	203	75-03-12	13.31	2400	1200	23.0	360
HA	203	75-09-08	18.52	2000	1000	23.0	335
HA	203	76-05-19	14.80	2000	1000	22.0	360
HA	210	75-09-08	17.15	1700	850	23.5	240
HA	210	76-05-19	13.19	1800	900	23.0	260
HA	218	75-03-11	11.80	2400	1200	22.0	350
HA	218	75-06-25	20.00	2350	1100	25.5	340
HA	218	75-09-04	19.52	2100	1050	24.5	310
HA	226	75-03-19	10.21	7400	4250	24.0	2290
HA	226	75-09-04	18.60	4800	2400	23.0	1230
HA	226	75-11-24	17.10	2700	1400	22.5	710
HA	226	76-01-13	16.20	7000	4000	24.0	2640
HA	226	76-02-25	11.75	5600	3200	24.0	2400
HA	226	76-04-14	9.90	5100	2850	24.4	2520
HA	226	76-05-19	13.90	7000	4000	24.0	2400
HA	226	76-09-22	17.75	4600	2500	25.0	1860
HA	263	75-09-04	18.61	2040	1020	25.0	400
HA	263	75-11-24	14.81	3000	1600	24.0	700
HA	263	76-01-13	15.41	3500	1800	23.0	820
HA	263	76-02-25	9.45	9800	5700	23.0	4480
HA	263	76-04-14	10.49	3800	2000	23.0	2150
HA	263	76-05-24	14.28	3600	1950	23.5	760
HA	263	76-09-22	17.81	2000	1000	25.0	460
HA	264	75-11-24	-	2600	1400	24.0	620
HA	264	76-02-25	-	2900	1500	23.0	825
HA	378	75-11-26	14.50	2400	1400	23.0	545
HA	378	76-01-13	14.25	2250	1150	22.0	710
HA	378	76-02-25	10.58	3400	1800	23.0	1240
HA	378	76-04-14	8.65	3500	1850	24.0	1360

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
HA	378	76-05-19	11.09	3800	2100	24.0	1070
HA	378	76-09-22	15.30	2000	1000	23.0	720
HA	379	75-09-04	18.60	2500	1250	23.0	480
HA	379	76-05-24	15.00	2400	1200	23.0	630
HA	466	75-09-04	17.60	1700	850	22.2	230
HA	466	76-05-19	13.28	1600	800	23.5	200
MI	10	75-06-26	24.80	1620	800	-	132
MI	10	75-11-25	25.80	1400	650	21.5	135
MI	10	76-01-12	25.90	1500	750	-	120
MI	10	76-02-17	23.40	1500	750	21.0	120
MI	10	76-04-05	17.80	1400	650	24.5	158
MI	10	76-05-19	22.10	1500	750	22.0	153
MI	10	76-09-21	26.00	1500	700	22.5	124
MI	26	75-03-18	15.50	1840	900	23.0	210
MI	26	75-06-26	20.20	1750	875	-	196
MI	26	75-09-04	22.80	1500	750	24.0	180
MI	26	75-11-25	21.80	1550	750	22.0	208
MI	26	76-01-12	21.70	1600	800	23.0	175
MI	26	76-02-17	19.20	1900	950	-	190
MI	26	76-04-05	14.20	1500	750	25.5	200
MI	26	76-05-19	18.00	1600	800	23.0	200
MI	26	76-09-21	22.00	1600	800	23.0	190
MI	46	74-12-12	33.20	710	364	22.5	26
MI	46	75-03-13	29.00	750	370	23.5	26
MI	46	75-07-02	33.60	730	350	23.0	24
MI	46	75-09-12	34.60	760	380	23.0	26
MI	46	76-05-26	31.35	800	400	23.0	30
MI	50	75-09-05	20.12	1500	750	24.0	190
MI	50	76-05-19	16.10	1700	850	23.0	220
MI	52	75-07-02	27.70	1850	900	23.0	100
MI	52	75-09-09	29.15	1600	800	23.8	62
MI	52	76-05-26	26.80	2000	1000	23.0	150
MI	53	75-03-18	13.90	2000	1000	20.0	290
MI	53	75-09-04	22.20	1700	850	25.0	270
MI	53	76-05-17	17.80	1900	950	-	270
MI	61	75-02-18	29.40	-	-	-	-
MI	61	75-03-13	29.80	999	450	24.0	24
MI	61	75-07-02	33.40	812	420	22.0	22
MI	61	75-09-12	34.60	800	400	25.0	25
MI	61	76-05-26	31.70	800	400	25.0	29
MI	76	75-03-17	12.80	2130	1000	23.0	310
MI	76	75-06-26	19.40	1940	950	-	290
MI	76	75-09-04	21.20	1900	900	24.5	290
MI	76	76-05-14	16.90	2000	1000	23.5	280
MI	76	76-09-21	20.90	1700	850	24.0	290
MI	92	75-03-18	17.70	1650	825	21.0	190
MI	92	75-06-26	21.70	1600	800	-	174
MI	92	75-09-04	24.20	1600	800	23.5	160
MI	92	76-05-19	19.30	1600	800	22.0	190
MI	92	76-09-21	23.50	1550	800	23.0	176
MI	107	75-03-13	13.72	-	-	-	-
MI	107	75-07-03	14.32	-	-	-	-
MI	107	75-09-10	15.32	-	-	-	-
MI	108	75-03-13	15.96	1250	650	23.0	240
MI	108	75-07-03	17.20	1200	600	23.0	265

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
MI	108	75-09-10	17.30	1400	700	24.0	240
MI	108	75-12-03	17.12	1300	650	23.0	245
MI	108	76-01-14	16.76	1200	600	24.0	250
MI	108	76-03-03	15.90	1400	700	23.0	240
MI	108	76-04-19	14.36	1100	600	24.0	240
MI	108	76-06-14	16.40	1100	550	23.5	180
MI	108	76-09-27	17.80	800	400	23.5	170
MI	111	75-03-11	-	2280	1150	24.6	210
MI	111	75-07-02	27.00	2060	1000	23.0	200
MI	111	75-09-09	27.10	2000	1000	24.5	200
MI	111	75-11-25	27.50	2000	1000	25.0	203
MI	111	76-01-13	27.45	2000	1000	25.0	200
MI	111	76-02-25	22.35	1800	900	21.0	190
MI	111	76-05-26	24.60	2000	1000	24.0	216
MI	111	76-09-21	27.34	1400	725	24.0	217
MI	112	75-09-09	25.60	2600	1300	22.5	390
MI	112	76-05-25	22.35	2400	1200	22.5	380
MI	114	75-09-04	23.50	1600	800	23.0	300
MI	114	75-11-25	22.25	1700	850	22.0	280
MI	114	76-01-13	22.70	1900	950	23.0	265
MI	117	75-01-15	-	1500	800	-	290
MI	117	75-03-13	-	1400	750	-	245
MI	117	75-07-02	-	1000	500	-	245
MI	117	75-09-26	-	800	400	-	100
MI	117	76-05-31	-	1200	600	-	275
MI	133	74-12-30	-	2600	1380	25.5	260
MI	133	75-03-12	20.50	2260	1100	26.7	264
MI	133	75-07-02	27.00	2500	1250	24.0	280
MI	133	75-09-09	28.40	2500	1250	26.8	260
MI	133	75-11-25	28.40	2400	1200	25.5	265
MI	133	76-01-13	27.30	2500	1250	27.0	270
MI	133	76-02-25	-	2000	1000	26.0	250
MI	133	76-04-13	17.00	1900	950	26.7	255
MI	133	76-05-26	25.80	2300	1150	26.0	360
MI	133	76-09-21	27.97	2000	1000	27.7	250
MI	193	75-03-10	12.90	3400	1650	-	725
MI	193	75-06-26	13.20	2900	1450	-	700
MI	193	75-09-12	14.15	2000	1000	-	490
MI	215	75-03-11	25.75	2190	1100	22.7	230
MI	215	75-07-02	29.00	2170	992	22.0	230
MI	215	75-09-09	29.60	2000	1000	23.0	200
MI	215	76-05-26	27.20	2000	1000	22.0	190
MI	255	75-03-14	10.78	500	275	22.5	31
MI	255	75-07-01	13.35	500	250	22.0	18
MI	255	75-09-17	16.20	400	200	23.5	16
MI	255	76-05-17	14.10	400	200	22.5	22
MI	290	75-03-10	21.40	3110	1600	22.0	470
MI	290	75-07-02	24.00	2620	1350	23.0	460
MI	290	75-09-09	24.85	2800	1400	23.8	450
MI	290	76-05-26	21.60	2100	1050	23.0	440
MI	371	75-03-10	11.28	-	-	-	-
MI	371	75-09-08	17.70	600	300	22.5	53
MI	371	76-05-25	15.83	700	350	22.0	35
MI	389	75-03-10	18.84	2110	900	23.5	250
MI	389	75-07-02	22.67	1050	500	23.0	136

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
MI	387	75-09-08	24.70	880	440	22.8	125
MI	389	76-05-25	20.80	1700	850	23.0	220
MI	395	74-12-17	27.20	2230	1100	23.0	218
MI	395	75-03-11	21.40	2460	1250	24.3	222
MI	395	75-07-02	26.50	2390	1150	23.0	240
MI	395	75-09-09	27.15	1800	900	24.5	190
MI	395	76-05-26	23.60	2100	1050	24.0	230
OR	57	75-03-17	-	3380	1700	24.0	650
OR	57	75-06-25	20.10	3000	1600	24.0	590
OR	57	75-09-04	24.15	2900	1400	25.0	570
OR	57	76-05-19	20.60	2800	1400	23.0	570
OR	57	76-09-21	24.10	2050	1050	24.0	570
OR	58	75-03-19	11.30	2250	1150	22.5	350
OR	58	75-06-25	17.20	2100	1100	24.0	345
OR	58	75-09-05	19.20	1800	900	24.0	340
OR	58	76-09-21	18.50	1700	850	24.0	340
OR	60	75-03-17	16.10	3400	1700	22.0	710
OR	60	75-06-25	19.40	3500	1800	24.0	715
OR	60	75-09-04	20.60	3200	1600	25.0	690
OR	60	76-05-19	17.30	3000	1500	24.0	720
OR	68	75-03-17	19.36	1710	855	22.5	370
OR	68	75-06-28	19.50	1800	900	24.0	370
OR	68	75-09-15	23.18	1600	800	24.0	350
OR	68	76-05-18	19.86	1200	600	24.0	370
OR	68	76-09-20	23.10	1500	800	24.5	360
OR	69	75-01-24	-	1800	850	22.0	250
OR	69	76-01-12	20.90	1800	850	22.0	260
OR	69	76-02-17	14.80	1900	950	22.0	230
OR	69	76-04-13	16.30	1500	750	23.0	240
OR	69	76-05-18	17.80	1900	950	22.5	240
OR	69	76-09-20	22.20	1700	850	23.0	260
OR	77	75-03-18	20.49	1800	900	23.8	370
OR	77	75-06-25	21.30	1800	900	24.0	345
OR	77	75-09-04	24.10	1500	750	25.0	350
OR	77	75-11-24	24.70	1850	950	23.0	370
OR	77	76-01-12	24.00	1500	750	24.0	350
OR	77	76-02-17	23.58	1600	500	23.0	390
OR	77	76-03-29	20.06	-	-	-	-
OR	77	76-04-14	19.78	1500	750	24.0	350
OR	77	76-05-18	21.27	1300	650	24.0	360
OR	77	76-09-20	24.80	1500	800	24.0	360
OR	78	75-03-19	11.70	2000	1000	22.5	360
OR	78	75-06-25	15.00	2300	1150	22.0	375
OR	78	75-09-04	14.40	1900	950	23.0	360
OR	90	75-06-25	19.10	3400	1800	23.0	730
OR	90	75-09-05	19.45	3200	1600	25.0	760
OR	90	76-05-18	16.90	3500	1750	23.0	770
OR	90	76-09-20	20.60	2900	1450	22.0	720
OR	95	75-03-18	17.85	3600	1800	25.5	920
OR	95	75-06-25	20.40	3600	1900	23.0	945
OR	100	75-03-08	19.44	1950	900	23.2	760
OR	100	75-06-26	20.20	1900	900	22.0	290
OR	100	75-09-04	23.45	1600	800	24.0	370
OR	100	76-05-18	20.00	1400	700	24.0	380
OR	107	75-03-17	11.21	5000	2500	24.0	1140

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
OR	107	75-06-26	15.00	4400	2400	24.0	1020
OR	107	75-09-04	15.90	2000	1000	24.5	390
OR	107	75-11-24	16.16	2200	1100	23.0	460
OR	107	76-01-12	15.43	3900	2000	24.0	1063
OR	107	76-02-17	13.02	4400	2400	23.5	1180
OR	107	76-04-13	11.18	3500	1900	23.0	820
OR	107	76-05-18	12.50	4100	2250	24.0	1120
OR	107	76-09-20	15.95	3500	1900	24.0	1000
OR	172	75-03-14	16.32	-	-	-	-
OR	172	75-06-26	19.40	-	-	-	-
OR	172	75-09-04	20.73	-	-	-	-
OR	172	75-11-24	21.56	-	-	-	-
OR	172	76-01-12	20.28	-	-	-	-
OR	172	76-02-17	20.21	-	-	-	-
OR	172	76-04-14	14.23	-	-	-	-
OR	172	76-05-18	12.93	-	-	-	-
OR	172	76-09-27	18.75	-	-	-	-
OR	178	75-03-17	16.91	900	450	23.5	170
OR	178	75-06-25	19.35	800	400	24.0	161
OR	178	75-09-04	21.00	800	400	24.5	170
OR	178	75-11-25	20.95	900	450	23.0	182
OR	178	76-01-12	20.39	800	400	24.0	165
OR	178	76-02-17	18.38	800	400	23.5	180
OR	178	76-03-29	-	-	-	-	170
OR	178	76-05-18	17.45	600	300	23.0	150
OR	178	76-09-20	20.95	700	350	24.0	185
OR	186	75-06-25	21.70	1200	600	23.0	260
OR	186	75-09-05	22.70	1000	500	24.5	220
OR	186	76-05-18	19.50	900	450	23.5	260
OR	190	74-11-15	-	-	-	-	162
OR	190	75-03-14	13.67	-	-	-	-
OR	190	75-07-15	13.88	-	-	-	-
OR	190	75-09-12	16.33	-	-	-	-
OR	218	75-03-19	19.10	738	370	-	130
OR	218	75-06-25	19.90	800	400	24.0	154
OR	218	75-09-04	21.60	800	400	24.5	160
OR	218	76-05-18	18.70	600	300	23.0	130
OR	218	76-09-20	21.80	700	325	24.0	129
OR	221	75-06-26	19.00	2000	1000	23.0	390
OR	221	75-09-05	20.25	1800	900	24.0	400
OR	229	75-09-04	16.95	3200	1600	25.0	940
OR	229	75-11-24	18.20	3000	1550	22.0	830
OR	229	76-01-12	16.60	2800	1400	22.5	930
OR	229	76-02-12	15.20	-	-	-	-
OR	230	75-03-17	11.35	1200	620	22.7	270
OR	230	75-06-26	13.00	1400	700	22.0	285
OR	311	75-03-17	-	1900	950	23.5	385
OR	311	75-06-26	18.30	2000	1000	22.0	485
OR	311	75-09-04	19.60	1800	900	24.0	450
OR	311	76-05-18	17.08	2000	1000	24.0	580
OR	333	75-03-19	14.70	3160	1525	22.5	610
OR	333	75-06-25	18.40	3500	1750	24.0	715
OR	333	75-09-04	17.70	2400	1200	24.0	440
OR	333	75-11-24	18.30	2050	1050	22.0	400
OR	333	76-01-12	17.45	2000	1000	23.0	425

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
OR	333	76-02-17	12,25	3500	1800	22,0	820
OR	333	76-04-13	13,30	2500	1250	23,0	850
OR	333	76-05-18	14,60	2200	1100	23,0	420
OR	333	76-09-21	17,00	2000	1000	23,0	470
PE	1	75-03-13	19.70	550	250	–	5
PE	1	75-07-03	19.74	500	250	–	24
PE	1	75-09-10	20,20	400	200	–	10
PE	1	76-06-14	19,91	500	250	–	20
PE	2	75-02-10	31.60	247	140	23.8	2
PE	2	75-03-11	30,60	232	130	24,0	6
PE	2	75-06-30	30,60	230	128	23,5	2
PE	2	75-09-16	33,55	300	150	25,0	9
PE	2	76-05-26	29.80	300	150	24,0	12
PE	3	75-01-23	23,90	259	130	22,0	4
PE	3	75-03-14	19.30	259	130	22,9	8
PE	3	75-06-30	22,70	263	132	27,5	2
PE	3	75-09-16	26.60	260	130	25.5	8
PE	3	76-05-26	25,00	350	150	23,0	10
PE	4	75-01-23	35.87	202	104	22,0	6
PE	4	75-03-11	35.40	201	–	22,0	4
PE	4	75-06-30	34.30	202	88	22,0	4
PE	4	75-09-16	37.27	200	100	23,0	7
PE	4	76-05-26	34.77	300	150	22,0	11
PE	4	76-10-19	35,77	–	–	–	–
PE	4	77-01-13	33,77	250	175	20,0	7
PE	20	75-02-13	30.60	1490	936	25.5	16
PE	20	75-03-13	26,60	1640	945	24,5	18
PE	20	75-07-02	29.40	1530	952	25.0	14
PE	20	75-09-12	30.80	1500	750	25,0	19
PE	20	76-05-26	29.10	1400	700	24.0	27
PE	83	75-01-15	17,33	–	–	–	–
PE	83	75-03-10	16,20	–	–	–	–
PE	83	75-06-26	16.15	1200	600	22,0	292
PE	83	75-09-15	17.42	1500	750	23,5	340
PE	84	75-01-15	–	2200	1200	22,0	460
PE	84	75-03-10	16.05	2400	1200	21,0	470
PE	84	75-06-26	15.13	2100	1050	22.0	450
PE	84	75-09-12	17.30	2000	1000	23.0	460
PE	87	75-03-13	13.52	–	–	–	–
PE	87	75-05-15	13.37	–	–	–	–
PE	87	75-09-10	14.25	–	–	–	–
PE	87	75-12-03	15,06	–	–	–	–
PE	87	76-03-04	13.09	–	–	–	–
PE	87	76-04-19	12.46	–	–	–	–
PE	87	76-05-31	13.46	1600	800	23.0	640
PE	87	76-09-27	15.15	–	–	–	–
PE	95	75-01-15	–	1250	600	22.4	265
PE	95	75-03-10	14,91	–	–	–	–
PE	95	75-09-12	15.30	900	450	23.0	255
PE	97	75-01-15	–	600	250	23.0	120
PE	97	75-03-13	10,66	900	425	23.0	120
PE	97	75-07-03	11,20	800	400	23,0	122
PE	97	75-09-10	12.20	–	–	–	–
PE	97	76-06-14	10.33	–	–	–	–
PE	115	75-03-01	15.03	–	–	–	–

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
PE	115	75-07-01	16.63	-	-	-	-
PE	115	75-09-01	17.38	-	-	-	-
PE	115	76-05-01	13.43	-	-	-	-
PE	115	76-09-01	15.43	-	-	-	-
PE	119	75-03-13	-	840	420	22.8	40
PE	119	75-07-02	-	880	440	21.5	46
PE	119	75-09-12	33.50	800	400	23.0	46
PE	119	76-01-13	33.15	950	450	22.0	49
PE	119	76-02-25	30.05	700	350	22.0	40
PE	119	76-03-05	26.59	800	400	22.0	43
PE	119	76-04-13	27.25	800	400	21.7	60
PE	119	76-05-26	30.40	900	450	22.0	40
PE	119	76-09-21	33.19	800	400	24.0	44
PE	128	75-03-11	13.35	-	-	-	-
PE	128	75-07-02	13.40	-	-	-	-
PE	128	75-09-26	14.62	-	-	-	-
PE	128	76-05-31	12.63	-	-	-	-
PE	128	76-09-27	14.75	-	-	-	-
PE	130	75-03-10	15.30	-	-	-	-
PE	130	75-07-02	15.23	-	-	-	-
PE	130	75-09-26	16.47	-	-	-	-
PE	130	76-06-14	15.32	-	-	-	-
PE	130	76-09-27	16.45	-	-	-	-
PE	134	75-04-15	12.80	5100	2900	23.0	1440
PE	134	75-07-07	12.80	5000	2700	23.0	1360
PE	134	75-09-26	15.70	4020	2250	23.5	1330
PE	134	75-12-03	14.60	4400	2400	23.0	1370
PE	134	76-01-14	14.10	4900	2500	23.5	1360
PE	134	76-03-03	13.10	3600	2000	22.5	1360
PE	134	76-04-19	12.40	2500	1250	24.0	1440
PE	134	76-05-31	12.60	5000	2700	23.0	1360
PE	134	76-06-14	13.40	3400	1750	23.0	1360
PE	134	76-09-27	15.10	2700	1400	24.0	1340
PE	168	75-04-12	25.00	2200	1100	24.0	156
PE	168	75-07-02	30.00	2100	1000	22.0	160
PE	168	75-09-09	31.80	2000	1000	24.0	159
PE	168	76-05-26	28.90	1900	950	24.0	150
PE	203	75-01-15	-	1200	600	23.0	190
PE	203	75-03-18	-	1900	990	22.5	420
PE	238	75-03-17	30.75	300	150	-	14
PE	238	75-07-01	31.10	-	-	-	20
PE	238	75-09-29	31.58	-	-	-	-
PE	238	76-05-17	29.66	200	100	22.0	17
PE	242	75-03-17	23.88	-	-	-	-
PE	242	75-07-01	23.67	-	-	-	-
PE	242	75-09-17	23.91	-	-	-	-
PE	242	76-05-17	22.28	-	-	-	-
PE	243	75-03-17	27.00	300	150	23.0	20
PE	243	75-07-01	27.70	350	175	23.0	24
PE	243	75-09-17	28.80	300	150	23.5	20
PE	243	76-05-17	26.90	300	150	23.0	28
PE	270	75-03-17	15.77	400	200	-	15
PE	270	75-07-01	16.45	-	-	-	-
PE	270	75-09-29	16.65	-	-	-	-
PE	270	76-05-17	15.74	-	-	-	-

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
PE	271	75-03-17	9.86	1000	450	21.5	136
PE	271	75-07-01	9.66	800	400	23.0	110
PE	271	75-09-29	10.80	800	400	24.0	133
PE	271	76-05-17	9.30	700	350	23.0	139
PE	273	75-03-17	2.40	-	-	-	-
PE	273	75-07-15	2.82	-	-	-	-
PE	273	75-09-29	3.25	-	-	-	-
PE	273	76-05-17	2.10	-	-	-	-
PE	280	75-03-15	19.47	750	375	-	315
PE	280	75-07-15	20.05	1500	700	22.5	420
PE	280	75-09-26	20.94	1100	550	24.0	300
PE	280	76-05-17	19.00	900	425	23.0	310
PE	284	75-03-17	25.50	900	450	22.0	230
PE	284	75-07-15	23.90	1150	600	23.0	230
PE	284	75-09-29	26.35	900	450	23.5	210
PE	284	76-05-11	24.50	900	450	23.0	236
PE	290	75-03-17	27.30	200	75	-	8
PE	290	75-06-30	27.20	200	100	23.0	10
PE	290	75-09-29	27.60	200	100	23.5	7
PE	290	75-12-05	28.10	275	150	23.6	13
PE	290	76-01-12	27.70	200	100	-	7
PE	290	76-02-25	27.45	300	150	22.0	11
PE	290	76-04-01	25.50	300	150	-	14
PE	290	76-05-11	25.40	300	150	-	15
PE	298	75-03-18	27.90	450	200	22.5	31
PE	298	75-07-11	28.50	400	200	22.0	34
PE	298	75-09-29	29.40	300	150	24.0	36
PE	298	76-05-14	27.20	350	175	24.0	41
PE	306	75-03-17	64.90	300	175	-	12
PE	306	75-07-15	64.40	100	50	23.0	11
PE	306	75-09-26	65.60	200	100	24.0	6
PE	306	76-05-11	63.60	200	100	23.0	11
PE	306	76-09-20	63.30	250	125	25.0	7
PE	315	75-02-10	30.00	-	-	-	-
PE	315	75-03-11	28.85	-	-	-	-
PE	315	75-03-13	-	550	270	22.0	12
PE	315	75-07-11	29.39	600	325	22.0	-
PE	315	75-09-26	30.50	-	-	-	-
PE	317	75-03-14	-	400	190	23.0	13
PE	317	75-07-01	12.10	400	200	-	22
PE	317	75-09-17	12.70	300	150	23.0	17
PE	317	76-05-17	11.40	400	200	23.0	21
PE	401	75-02-18	32.70	800	400	24.3	34
PE	401	75-03-13	29.80	806	400	24.0	30
PE	401	75-07-02	31.70	812	400	24.0	30
PE	401	75-09-12	32.70	800	400	24.0	32
PE	401	76-05-26	29.90	800	400	24.0	30
PE	406	75-03-12	33.90	920	450	24.0	20
PE	406	75-07-02	38.30	910	450	23.0	18
PE	406	75-09-12	38.90	900	450	24.0	19
PE	406	76-05-26	36.05	900	450	24.0	25
PE	412	75-03-10	33.40	1110	450	23.0	88
PE	412	75-06-30	32.80	760	380	23.0	88
PE	412	75-09-18	34.00	640	320	23.5	89
PE	412	76-05-27	32.30	900	450	23.5	93

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
PE	412	76-09-27	-	900	425	24.5	90
PE	413	75-01-10	23.89	1100	456	22.8	90
PE	413	75-03-10	24.59	1018	490	22.5	86
PE	413	75-06-30	24.39	1070	460	23.0	86
PE	413	75-09-18	23.89	900	450	24.0	86
PE	413	76-05-31	20.79	1200	600	24.0	89
PE	415	75-01-10	21.50	1230	502	23.3	165
PE	415	75-03-10	21.90	1320	650	23.5	156
PE	415	75-06-30	20.60	1240	480	23.0	140
PE	416	75-01-14	31.50	757	332	22.5	70
PE	416	75-03-10	31.70	814	400	23.0	66
PE	416	75-06-30	30.60	837	340	23.5	64
PE	416	75-09-18	32.70	800	400	24.5	76
PE	416	76-05-27	30.10	800	400	23.0	70
PE	418	75-01-15	32.80	835	464	23.0	10
PE	418	75-03-11	32.10	868	470	20.0	16
PE	418	75-06-30	32.10	870	472	24.0	14
PE	418	75-09-16	33.50	800	400	24.0	17
PE	418	76-05-26	30.90	900	450	22.5	15
PE	422	75-01-15	39.70	820	444	23.0	18
PE	422	75-03-11	39.70	855	430	21.5	18
PE	422	75-06-30	38.70	870	440	23.0	16
PE	422	75-09-16	40.30	800	400	23.0	19
PE	422	76-05-27	37.30	800	400	23.0	30
PE	427	75-01-15	37.75	700	368	24.0	16
PE	427	75-03-11	37.85	731	390	23.5	16
PE	427	75-06-30	37.15	750	364	24.5	16
PE	427	75-09-16	38.75	680	340	24.5	17
PE	427	76-05-26	35.55	700	350	24.0	24
PE	428	75-01-31	19.00	1420	552	23.0	200
PE	428	75-03-10	18.60	1590	700	19.5	190
PE	428	75-06-30	18.00	1340	436	26.0	192
PE	428	75-09-18	18.90	1100	550	24.0	190
PE	429	75-03-13	30.54	2530	1200	23.5	530
PE	429	75-06-30	30.54	2450	1200	24.0	510
PE	429	75-09-18	27.06	-	-	-	-
PE	432	75-01-31	13.10	10200	5800	26.2	3380
PE	432	75-03-10	12.60	10360	5900	20.0	3410
PE	432	75-06-30	12.60	12000	6400	23.0	3350
PE	432	75-09-26	14.10	9400	5400	23.0	3260
PE	432	75-11-25	13.10	9200	5100	21.5	3320
PE	432	76-01-14	12.70	9100	5200	22.0	3220
PE	432	76-03-04	11.00	7400	4250	21.0	3320
PE	432	76-04-05	10.75	7100	4100	22.8	3460
PE	432	76-05-31	10.50	8000	4600	25.0	3400
PE	432	76-09-21	12.69	-	-	25.5	3300
PE	433	75-01-14	32.60	955	346	24.5	140
PE	433	75-03-10	33.10	1120	350	25.0	138
PE	433	75-06-30	32.10	1030	352	23.5	140
PE	433	75-09-18	33.30	900	450	23.0	138
PE	433	76-05-27	37.80	900	450	23.0	146
PE	434	75-01-15	41.07	730	380	21.0	20
PE	434	75-03-10	40.57	755	390	23.0	20
PE	434	75-06-30	39.87	785	380	24.5	16
PE	434	75-09-18	41.07	700	350	23.5	21

TABLE 2 CONTD.

CONE	LOC #	DATE OF READING	WATER LEVEL	SPEC. COND.	SALT CONT.	WATER TEMP	CHLORIDE CONTENT
PE	434	76-05-27	39.47	750	375	23.0	23
PE	435	75-03-10	36.96	-	-	-	-
PE	435	75-05-15	35.90	-	-	-	-
PE	435	75-09-04	38.09	-	-	-	-
PE	435	75-12-03	38.70	-	-	-	-
PE	435	76-03-15	36.96	-	-	-	-
PE	436	75-01-16	39.40	364	176	22.5	10
PE	436	75-03-11	39.70	381	180	21.5	10
PE	436	75-06-30	38.40	390	172	24.0	10
PE	436	75-09-16	37.50	380	190	24.0	11
PE	436	76-05-26	39.10	400	200	23.5	16
PE	438	75-01-14	33.10	930	348	22.5	118
PE	438	75-03-10	34.40	957	350	21.5	116
PE	438	75-06-30	33.80	985	360	23.0	116
PE	438	75-09-18	34.40	840	420	24.0	115
PE	438	76-05-27	34.50	900	450	22.0	124
PE	458	75-05-15	33.16	-	-	-	-
PE	458	75-09-04	34.19	-	-	-	-
PE	458	75-12-05	34.73	-	-	-	-
PE	458	76-03-15	29.44	-	-	-	-

ABBREVIATIONS AND UNITS

DATE OF READING = YEAR/MONTH/DAY
WATER LEVEL = - FEET (+ OR -) MEAN SEA LEVEL
SPEC. COND. = SPECIFIC CONDUCTANCE IN MICRO MHOS/CENTIMETER
SALT CONT. = SALT CONTENT IN PARTS PER MILLION
WATER TEMP. = WATER TEMPERATURE IN DEGREES CENTIGRADE
CHLORIDE CONTENT = CHLORIDE CONTENT IN PARTS PER MILLION
DASH (-) = NOT SAMPLED

GEOPHYSICAL LOGGING DATA

GEOPHYSICAL LOGGING DATA

For the study, 82 wells were geophysically logged (Figure 2) to obtain geologic and hydrologic information (Table 3). The wells ranged from 113 feet Total Depth Logged (TDL) to 1,656 feet TDL. Four were test and/or observation wells, 38 were active irrigation wells, and 40 were presently unused or abandoned irrigation wells.

Generally, four types of geophysical logs were run. Logs were run in the following order: (1) caliper log: continuously records borehole diameter and is used to correct electric log quantitative values; (2) electric log: records the electrical resistivity of the lithological material in the open hole (uncased) from which correlations can be made; (3) natural gamma ray log: measures the natural gamma ray radiation intensity within the well (both cased and uncased) from which the lithology can be deduced; and (4) flow meter logs run when the well is flowing naturally or is being pumped and shows water producing zones.

Downhole water samples were also taken. Samples were taken only after the well had been undisturbed for at least one day and collected from top to bottom of the well to insure minimum disturbance and mixing (Tables 4 and 5).

Geophysical logging data collected were used to construct all geologic maps found in the Geology Section of Technical Report No. 2, "Saline Contamination of a Limestone Aquifer by Connate Intrusion in Agriculture Areas of St. Johns, Putnam, and Flagler Counties, Northeast Florida", St. Johns River Water Management District, July 1979.

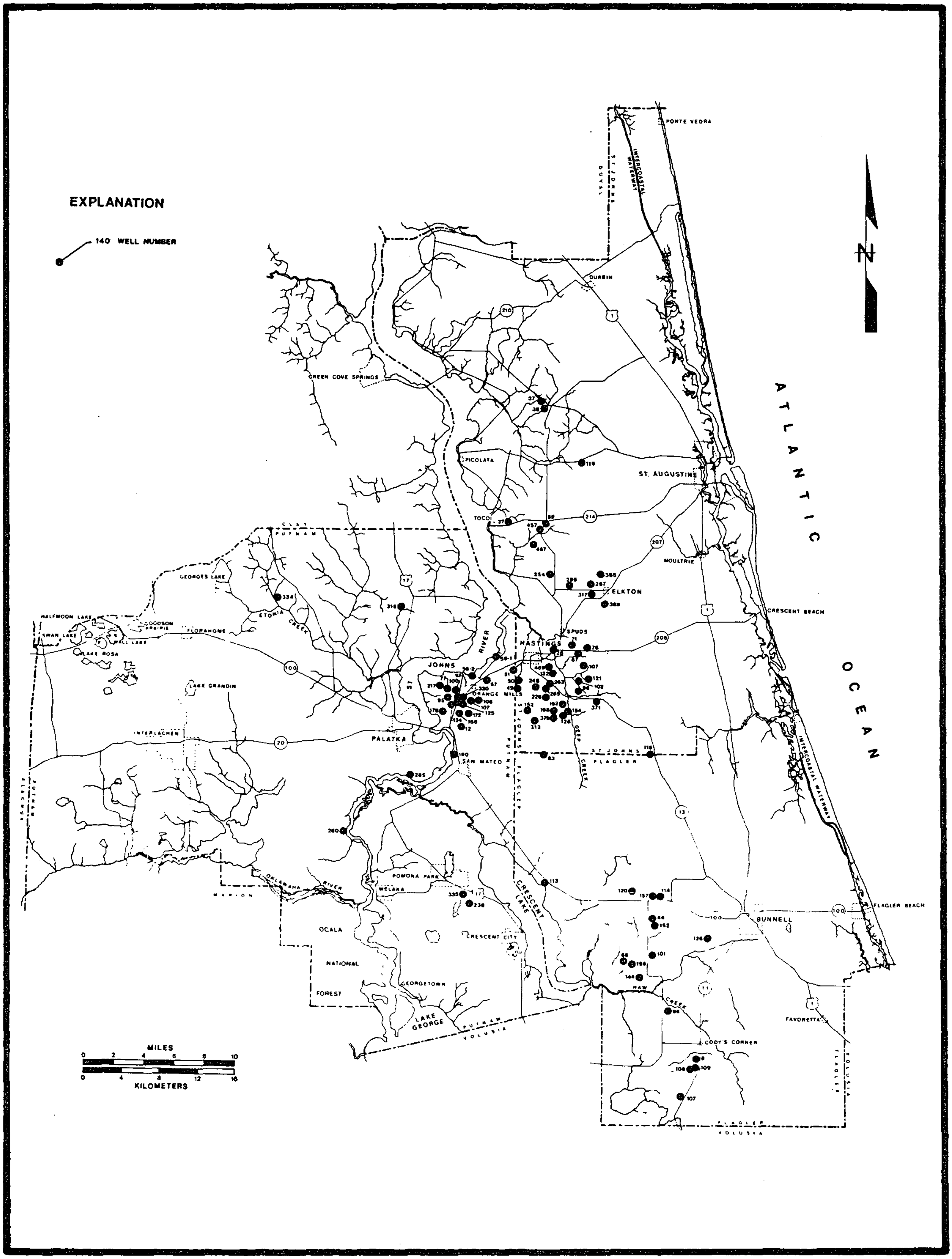


FIGURE 2. -- Location of All Wells Geophysically Logged in the Tri-County Study Area

TABLE 3. -- PERTINENT GEOLOGIC AND HYDROLOGIC DATA FROM ALL LOGGED WELLS

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth (ft. below MSL)				Water-producing Zones (ft. below MSL)
			Hawthorn	Ocala	Avon Park	Lake City	
St. Johns Co.							
SJ 119	29°54'42"N/81°27'22"	188'/131'/4"	26	--	--	--	
SJ 37	29°50'52"N/81°31'59"	377'/142'/6"	76	225	--	--	248-258 major
SJ 89	29°50'48"N/81°29'54"	277'/152'/4"	48	219	--	--	217-237
SJ 457	29°50'36"N/81°29'59"	254'/154'/6"	71	232	--	--	
SJ 467	29°49'47"N/81°30'22"	526'/152'/8"	90	248	495	--	
SJ 388	29°47'57"N/81°26'07"	388'/137'/6"	45	179	--	--	1) 223-238 major 2) 248-303
SJ 254	29°47'27"N/81°29'13"	324'/124'/4"	28	184	--	--	
SJ 286	29°47'27"N/81°27'52"	401'/140'/6"	33	123	--	--	178-183
SJ 267	29°47'22"N/81°26'49"	304'/94'/4"	34	149	--	--	
SJ 389	29°46'12"N/81°25'34"	301'/105'/4"	45	125	--	--	
SJ 71	29°43'29"N/81°28'02"	199'/106'/4"	59	172	--	--	
SJ 26	29°43'33"N/81°29'35"	226'/142'/4"	38	155	--	--	1) 137-180 major 2) 180-221
SJ 76	29°43'34"N/81°27'08"	400'/150'/6" 65'/8"	49	170	--	--	1) 178-208 major 2) 208-303 3) 303-323
SJ 67	29°43'29"N/81°28'02"	208'/103'/4"	53	164	--	--	

TABLE 3. (CONTINUED)

Sheet 2 of 6

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth (ft. below MSL)				Water-producing Zones (ft. below MSL)
			Hawthorn	Ocala	Avon Park	Lake City	
St. Johns Co.							
SJ 107	29°42'38"N/81°28'57"	592'/104'/4"	48	147	388	--	
SJ 459	29°42'13"N/81°29'01"	422'/139'/4"	76	177	413	--	
SJ 132	29°41'58"N/81°28'57"	445'/128'/4"	70	172	403	--	1) 400-402 2) 301-303 3) 198-208
SJ 50	29°41'34"N/81°31'25"	235'/65'/4"	26	103	--	--	177-181
SJ 102	29°41'22"N/81°27'12"	197'/131'/6"	35	164	--	--	
SJ 121	29°41'33"N/81°26'28"	348'/171'/8"	36	160	--	--	281-292
SJ 263	29°41'20"N/81°29'20"	540'/117'/6"	39	181	408	--	1) 183-198 2) 406-410 3) 455-458 4) 498-503
SJ 265	29°41'16"N/81°29'22"	465'/60'/5"	37	162	383	--	
SJ 99	29°41'08"N/81°27'12"	505'/122'/6"	43	157	386	--	
SJ 248	29°41'13"N/81°30'07"	503'/74'/6"	37	142	365	--	405-409
SJ 49	29°41'08"N/81°31'27"	252'/104'/6"	22	94	--	--	212-216
SJ 226	29°40'53"N/81°29'27"	497'/80'/4"	39	159	371	--	
SJ 371	29°40'40"N/81°25'56"	174'/157'/6"	55	--	--	--	
SJ 192	29°40'15"N/81°28'16"	278'/94'/4"	44	154	--	--	259-261

TABLE 3. (CONTINUED)

Sheet 3 of 6

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth(ft. below MSL)				Water-producing Zones (ft. below MSL)
			Hawthorn	Ocala	Avon Park	Lake City	
St. Johns Co.							
SJ 152	29°40'03"N/81°30'46"	448'/90'/4"	23	91	?	--	
SJ 168	29°39'48"N/81°28'43"	297'/146'/4"	41	159	--	--	
SJ 154	29°39'55"N/81°28'00"	295'/91'/4"	40	152	--	--	255-265
SJ 378	29°39'43"N/81°28'42"	291'/114'/4"	50	156	--	--	200-242
SJ 128	29°29'45"N/81°28'10"	251'/86'/4"	45	139	--	--	1) 139-141 major 2) 139-184
SJ 212	29°39'22"N/81°30'13"	353'/60'/4"	22	80	265	--	109-159
SJ 35	29°57'50"N/81°30'18"	358'/190'/8"	66	244	--	--	
SJ 37	29°58'17"N/81°30'46"	385'/167'/6"	57	230	--	--	
SJ 317	29°47'02"N/81°26'33"	274'/99'/6"	42	134	--	--	
Putnam Co.							
P 335	29°28'17"N/81°33'45"	484'/123'/10"	56	60	156	407	
P 315	29°45'40"N/81°38'33"	350'/136'/6"	79	208	--	--	
P 56-1	29°42'57"N/81°32'48"	196'/90'/6"	61	150	--	--	
P 51	29°42'08"N/81°31'32"	280'/125'/4"	57	158	--	--	158-192
P 57	29°41'55"N/81°33'15"	407'/140'/8"	59	137	--	--	139-149
P 56-2	29°41'44"N/81°34'18"	150'/118'/6"	60	--	--	--	

TABLE 3. (CONTINUED)

Sheet 4 of 6

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth(ft. below MSL)				Water-producing Zones (ft. below MSL)
			Hawthorn	Ocala	Avon Park	Lake City	
Putnam Co.							
P 217	29°40'53"N/81°36'30"	396'/65'/6"	24	93	237	--	
P 77	29°40'58"N/81°35'50"	262'/92'/4"	17	96	--	--	185-190
P 100	29°40'45"N/81°35'15"	236'/84'/4"	30	125	--	--	
P 97	29°40'30"N/81°35'00"	200'/64'/4"	23	97	--	--	
P 95	29°40'27"N/81°35'48"	460'/115'/6"	21	93	245	434	1) 261-274 2) 425-427
P 106	29°40'24"N/81°34'10"	184'/52'/4"	17	100	--	--	
P 107	29°40'22"N/81°34'13"	400'/80'/4"	17	94	267	--	346-351
P 330	29°40'18"N/81°35"07"	195'/70'/4"	20	89	--	--	
P 125	29°40'08"N/81°35'06"	116'/52'/4"	24	85	--	--	
P 124	29°40'08"N/81°35'17"	183'/62'/4"	22	84	--	--	
P 104	29°40'05"N/81°35'30"	204'/85'/4"	23	96	--	--	
P 178	29°39'42"N/81°36'11"	399'/88'/4"	51	123	271	--	323-326
P 172	29°39'32"N/81°34'28"	539'/115'/6"	37	99	284	472	181-191 major, with remainder of borehole contributing also
P 166	29°39'32"N/81°34'59"	100'/84'/3"	33	--	--	--	
P 12	29°38'45"N/81°34'48"	298'/88'/4"	51	126	--	--	

TABLE 3. (CONTINUED)

Sheet 5 of 6

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth (ft. below MSL) Hawthorn	Ocala	Avon Park	Lake City	Water-producing Zones (ft. below MSL)
Putnam Co.							
P 332	29°38'36"N/81°36'55"	178'/62'/4"	75	--	--	--	
P 190	29°37'38"N/81°35'16"	1,656'/765'/13"	96	207	?	620	
P 280	29°32'34"N/81°42'41"	295'/152'/4"	84	169	--	--	
P 334	29°46'18"N/81°47'34"	1,397'/143'/20"	+35	90	250	448	920-925
P 238	29°28'07"N/81°33'08"	425'/125'/10"	82	97	188	--	
P 285	29°34'19"N/81°41'56"	202'/90'/4"	75	123	--	--	136
Flagler Co.							
F 115	29°37'29"N/81°22'14"	613'/145'/6"	57	107	244	392	
F 83	29°37'16"N/81°29'26"	412'/96'/6"	71	145	269	--	214-272
F 113	29°29'05"N/81°23'58"	142'/116'/4"	97	--	--	--	
F 120	29°29'20"N/81°23'27"	307'/132'/6"	103	145	269	--	
F 157	29°29'08"N/81°21'54"	277'/151'/4"	107	147	--	--	
F 114	29°29'08"N/81°21'50"	377'/129'/8"	105	144	258	--	
F 44	29°27'50"N/81°22'11"	443'/170'/8"	103	181	279	--	
F 126	29°26'47"N/81°18'20"	157'/122'/6"	100	104	--	--	
F 101	29°25'38"N/81°22'02"	113'/110'/6"	93	--	--	--	
F 66	29°25'23"N/81°23'47"	198'/95'/6"	54	76	--	--	

TABLE 3. (CONTINUED)

Sheet 6 of 6

Well No.	Latitude/Longitude	TDL/Casing Depth/Size	Top of Formations Depth(ft. below MSL)				Water-producing Zones (ft. below MSL)
			Hawthorn	Ocala	Avon Park	Lake City	
Flagler Co.							
F 156	29°25'12"N/81°23'03"	234'/110'/5"	91	97	--	--	97-114
F 144	29°24'31"N/81°22'44"	250'/132'/6"	111	119	--	--	
F 96	29°22'26"N/81°20'56"	141'/59'/4"	47	56	?	--	
F 8	29°19'16"N/81°18'40"	164'/87'/6"	32	38	129	--	1) 68-78 major 2) 78-115
F 108	29°19'02"N/81°18'56"	325'/59'/6"	26	30	123	--	295-298
F 109	29°19'03"N/81°18'55"	168'/60'/4"	27	30	124	--	
F 107	29°17'20"N/81°19'44"	167'/66'/6"	24	29	121	--	1) 37-71 major 2) 71-133
F 152	29°27'37"N/81°22'02"	446'/192'/6"	106	183	287	--	

Sheet 1 of 2

TABLE 4. -- STRATIFIED SAMPLING WATER QUALITY DATA

Well No.	Sample Depth (ft. below lsd)	Conductivity (µmhos/cm)	Chloride (ppm)	Date Sampled
St. Johns Co.				
SJ 37	0	2,000	--	1/30/76
	230	1,950	190	
	280	2,050	50	
	370	1,500	210	
SJ 76	200	2,200	310	3/31/76
	250	2,150	300	
	300	2,050	300	
	350	2,050	280	
	395	1,800	240	
SJ 107	193	3,300	1,220	6/2/76
	250	3,500	2,220	
	300	3,550	1,240	
	500	3,550	1,260	
	580	2,300	640	
SJ 121	180	2,000	430	2/3/76
	250	2,600	610	
	330	4,400	1,360	
SJ 263	120	10,000	3,780	2/5/76
	150	8,900	3,600	
	250	8,000	2,700	
	350	7,300	2,580	
SJ 265	60	5,800	--	2/5/76
	100	5,800	--	
	150	5,500	--	
	200	4,500	--	
	250	5,700	--	
	300	6,900	--	
	350	6,600	--	
	400	6,400	--	
	460	7,300	--	
SJ 226	180	5,400	1,740	3/30/76
	250	7,100	2,200	
	300	7,100	2,420	
	350	7,300	2,380	
	400	7,600	2,460	
	450	7,500	2,360	
	485	7,400	2,320	

TABLE 4. (CONTINUED)

Sheet 2 of 2

Well No.	Sample Depth (ft. below lsd)	Conductivity (µmhos/cm)	Chloride (ppm)	Date Sampled
Putnam Co.				
P 107	130	2,500	1,000	3/30/76
	200	3,450	1,050	
	250	3,600	1,060	
	300	3,700	1,060	
	350	3,850	1,060	
	390	4,300	1,210	
P 172	122	2,400	490	1/29/76
	220	2,500	650	
	350	4,500	1,320	
	450	6,800	2,340	
P 335	130	250	80	12/21/76
	220	250	80	
	300	250	80	
	370	250	80	
	465	250	80	
Flagler Co.				
F 115	200	2,100	480	3/3/76
	330	2,200	490	
	450	2,300	490	
	530	2,700	690	
	600	2,400	590	
F 44	180	1,200	180	3/24/76
	235	1,450	290	
	300	2,900	920	
	350	2,800	910	
	400	2,850	910	
	435	3,700	1,240	
F 108	70	1,000	230	4/2/76
	110	1,150	240	
	150	1,150	240	
	200	1,150	250	
	260	1,150	240	
	315	1,150	240	

Sheet 1 of 2

TABLE 5. -- BOTTOM HOLE SAMPLING WATER QUALITY DATA

Well No.	Sample Depth (ft. below lsd)	Conductivity (μmhos/cm)	Chloride (ppm)	Date Sampled
St. Johns Co.				
SJ 37	370	1,500	210	1/30/76
SJ 388	385	1,400	--	1/7/76
SJ 254	318	1,900	320	1/27/76
SJ 286	395	2,000	--	12/29/76
SJ 267	300	1,500	220	1/28/76
SJ 389	295	1,700	--	1/8/76
SJ 71	194	2,400	410	3/25/76
SJ 26	220	2,700	370	2/19/76
SJ 76	395	1,800	240	12/31/76
SJ 67	204	2,400	370	3/25/76
SJ 107	580	2,300	640	6/2/76
SJ 459	415	5,000	--	2/20/76
SJ 132	440	2,200	410	3/18/76
SJ 121	330	4,400	1,360	2/3/76
SJ 263	350	7,300	2,580	2/5/76
SJ 265	460	7,300	--	2/5/76
SJ 99	490	1,900	480	6/3/76
SJ 248	498	1,000	180	9/14/76
SJ 49	240	2,100	380	6/17/76
SJ 226	485	7,400	2,320	3/30/76
SJ 192	271	4,100	1,140	3/16/76
SJ 154	290	3,600	1,010	2/23/76
SJ 378	270	4,400	1,700	2/25/76
SJ 128	245	2,900	770	2/23/76
SJ 212	345	1,800	300	2/26/76
Putnam Co.				
P 315	340	300	28	10/5/76
P 57	400	5,500	2,100	4/9/76
P 107	390	4,300	1,210	3/30/76
P 104	200	2,500	1,275	1/22/76
P 178	390	1,050	230	2/17/76
P 172	520	7,200	3,060	1/28/76
P 12	290	1,600	600	7/12/76

TABLE 5. (CONTINUED) Sheet 2 of 2

Well No.	Sample Depth (ft. below lsd)	Conductivity (µmhos/cm)	Chloride (ppm)	Date Sampled
Flagler Co.				
F 115	600	2,400	590	3/3/76
F 83	405	2,300	780	2/2/76
F 157	260	2,300	570	3/5/76
F 114	370	--	950	8/26/76
F 44	438	3,200	--	3/23/76
F 156	230	3,700	1,230	3/24/76
F 144	200	5,500	--	12/22/76
F 108	320	1,000	--	1/9/76
F 109	150	1,200	230	3/4/76
F 107	163	900	70	2/11/76

STATISTICS SECTION

STATISTICS SECTION

Found in this section is the supplemental data used for interpretations presented in the "Seasonal Fluctuations in Potentiometric Levels and Chloride Concentrations" portion of Technical Report No. 2. Present herein are the distributions and histograms for chloride data collected throughout the study period and a brief description of gamma distributions.

GAMMA PROBABILITY DISTRIBUTIONS

A. The Gamma Distribution

The gamma probability distribution is given as:

$$f(x) = \frac{a}{\Gamma(b)} (ax)^{b-1} e^{-ax}, \; x > o \qquad (1)$$

$$= 0, \text{ otherwise}$$

where a and b are the parameters of the distribution.

The mean (μ_x), variance (σ_x^2), and the coefficient of skewness (γ_x) of the gamma distribution are given by the following equations:

$$\mu_x = b/a \qquad (2)$$

$$\sigma_x^2 = b/a^2 \qquad (3)$$

$$\gamma_x = 2.0/\sqrt{a} \qquad (4)$$

B. Shapes of the Gamma Distributions at a Given Mean and Variance

Define the random variable K such that

$$K_i = X_i/\bar{X} \qquad (5)$$

in which $\bar{X}$ is the mean of X_i's. It can be easily shown that the mean of K_i's is 1.0. If μ_K and σ_K^2 are the population mean and variance of K, the variable

K has the unique property that $\mu_K = 1.0$. The shapes of the gamma distribution at a given mean and variance can be determined by substituting X by K in equations (1) through (4) (Rao, 1978). For a given variance, σ_K^2, determine the parameters of the distribution by assuming $\mu_K = 1.0$.

The shape of the gamma distributions for different values of σ_K^2 is given in Figure 3.

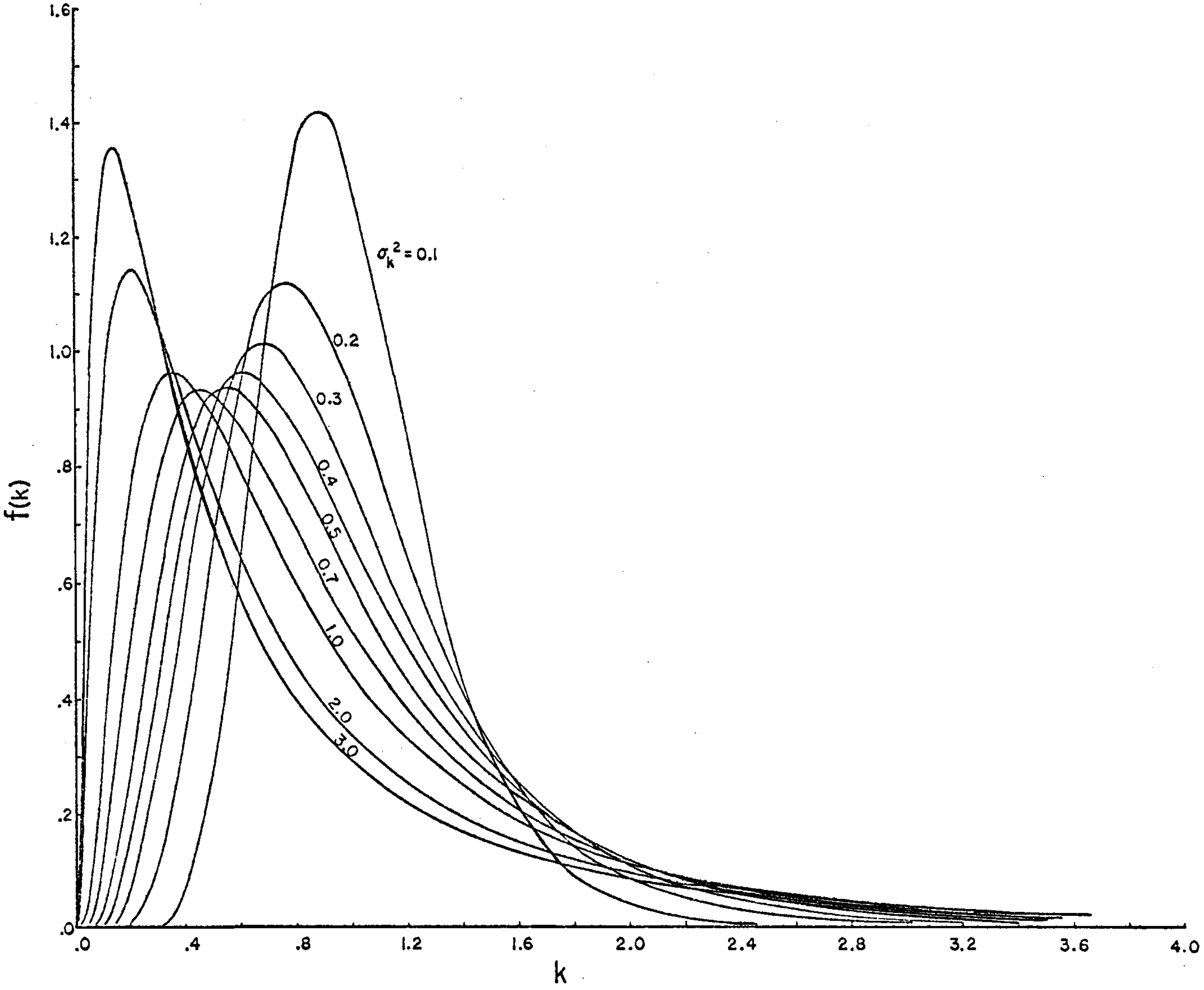


FIGURE 3. — The Gamma Distribution ($\mu_K = 1.0$) (Source: Rao, 1978)

DISTRIBUTION OF CHLORIDES IN WELLS

The chloride data were fit to probability distributions in order to generalize the distribution of chloride concentrations occurring in the wells of the study area. Chloride data were then arranged as frequency histograms for each study month. If these data are approximated by one of the theoretical probability distributions, it will permit drawing certain inferences such as what percent of wells on the average will have a chloride concentration greater than a given magnitude, or what is the highest chloride concentration expected in a given percentage of wells.

An examination of different probability distributions showed that the chloride data will closely fit a gamma distribution given by the following equation:

$$f(k) = \frac{a}{\Gamma(b)} (ak)^{b-1} e^{-ak} \qquad (6)$$

where: k is as defined by Eq. (5)

$k = Q/\bar{Q}$

For the study months of March 1975, July 1975, September 1975, and May 1976, the chloride data were fit to the gamma distribution by the method of maximum likelihood. (The study month of September 1976 was excluded from this analysis because of inadequate data.) Figures 4 through 7 show the frequency histogram and the fitted distribution for the above study months.

Table 6 summarizes the data. Column A represents the chloride concentration that 50 percent of the wells will be less than or equal to, and column B represents the chloride concentration that 10 percent of the wells will be greater than or equal to.

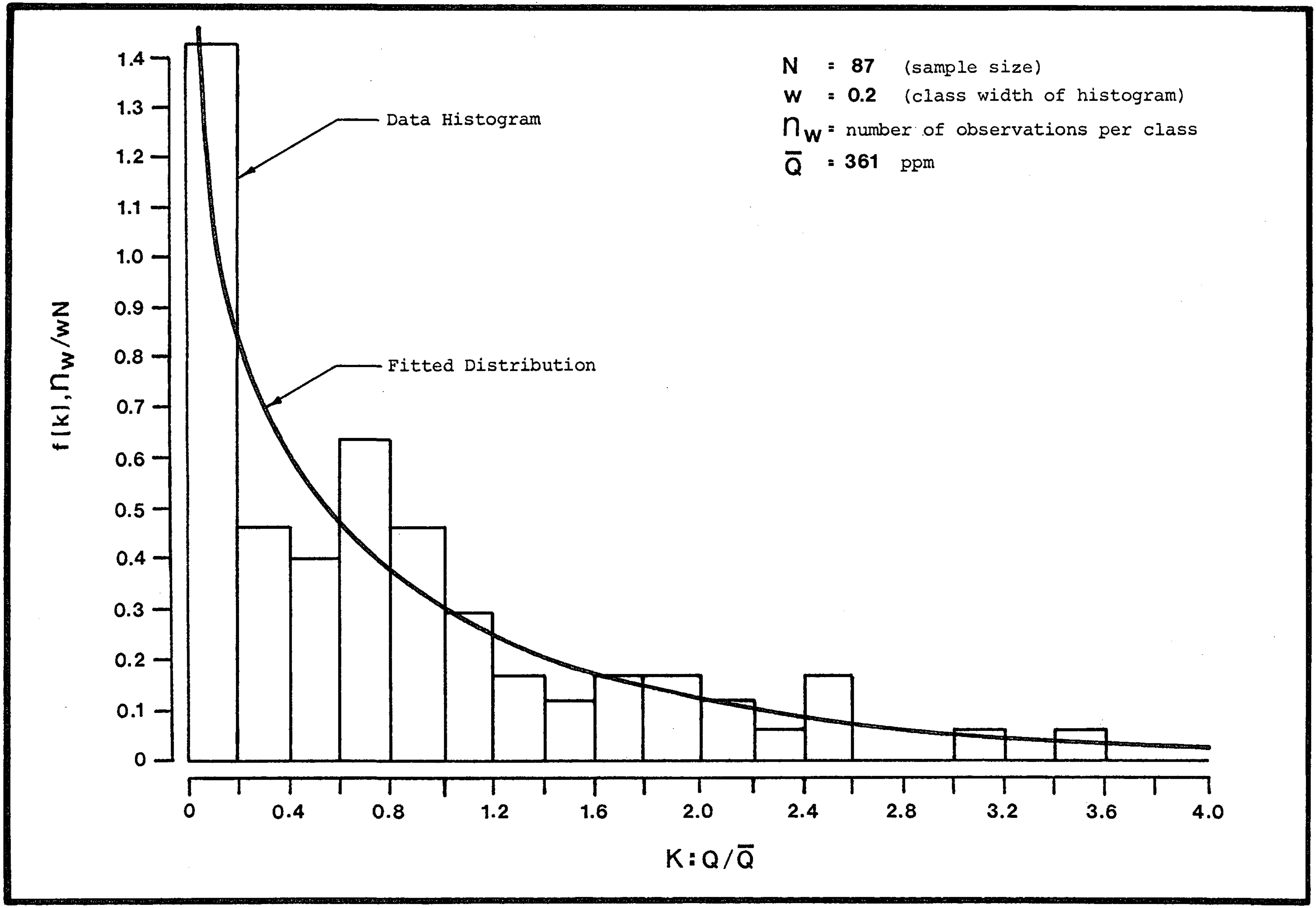


FIGURE 4. -- Distribution of Chloride Concentrations in Wells Within the Study Area, March 1975

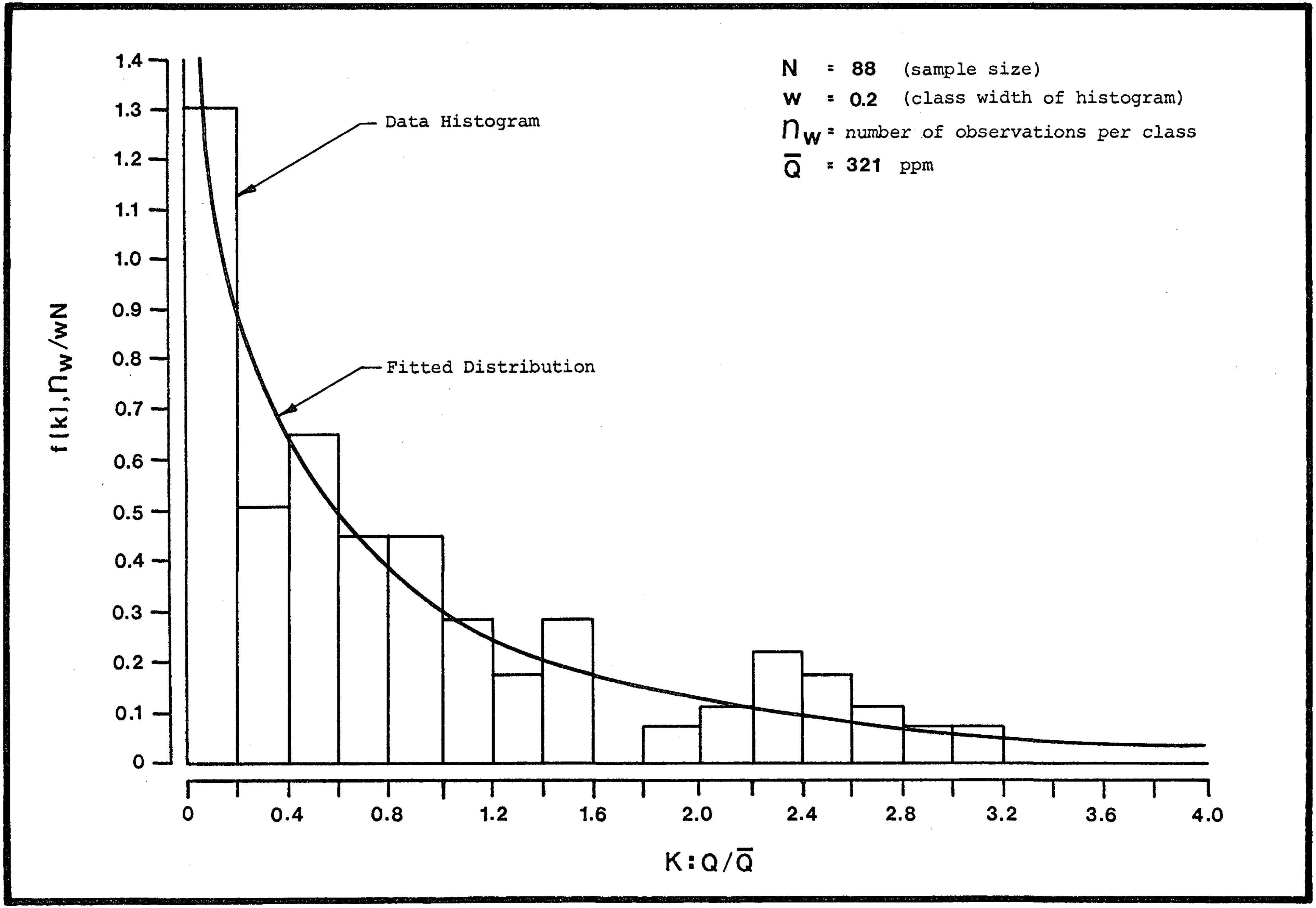


FIGURE 5. -- Distribution of Chloride Concentrations in Wells Within the Study Area, July 1975

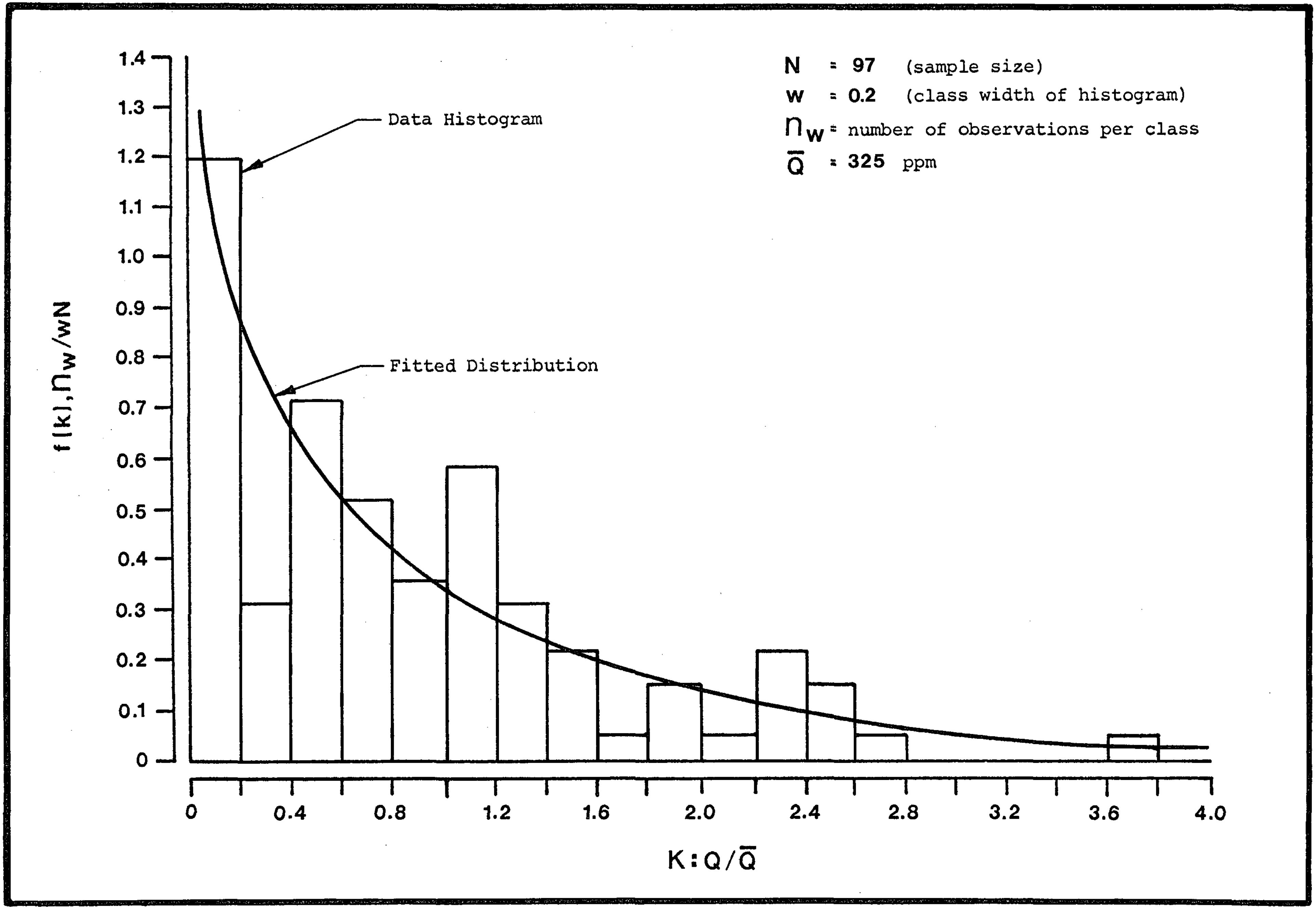


FIGURE 6. -- Distribution of Chloride Concentrations in Wells Within the Study Area, September 1975

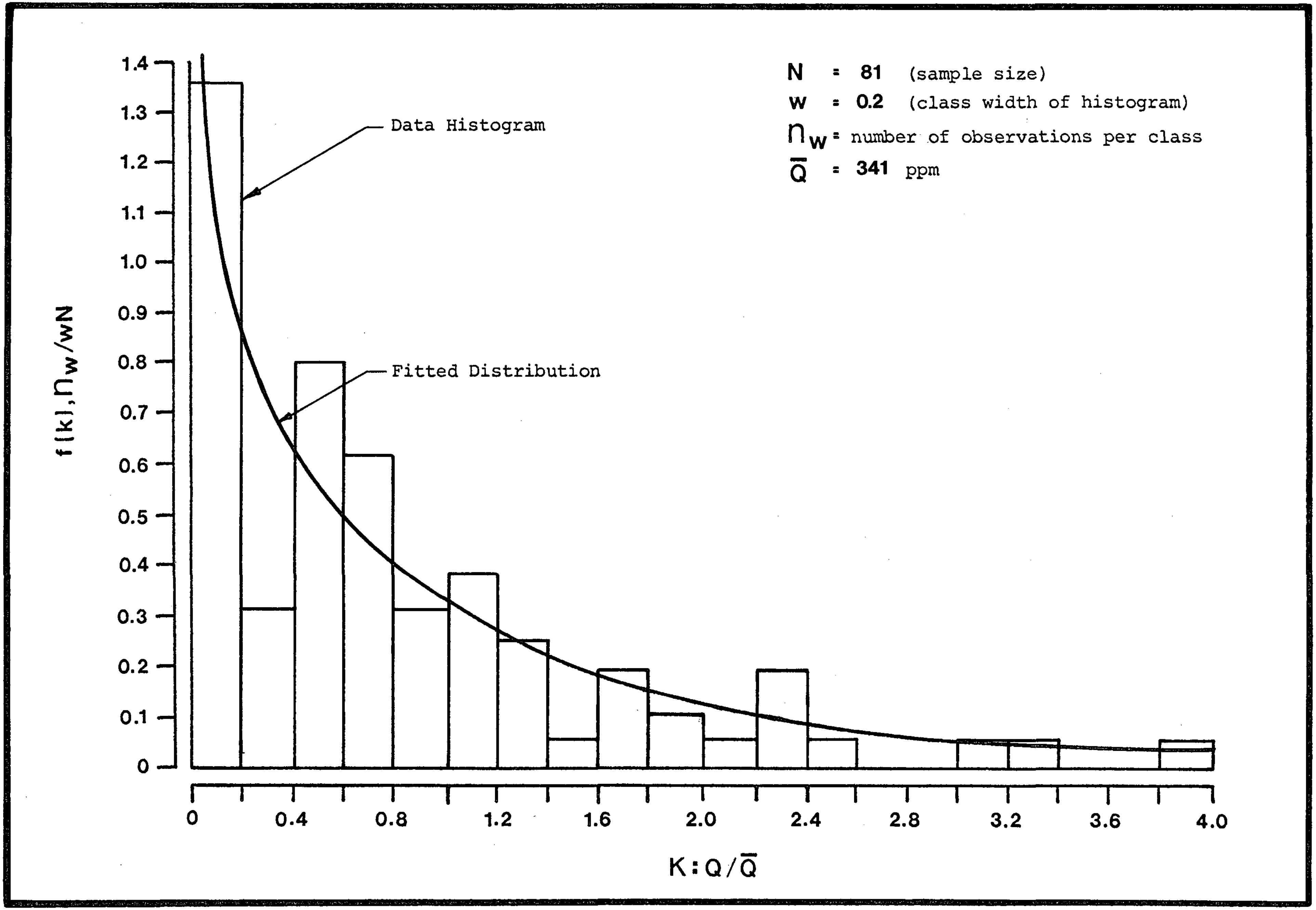


FIGURE 7. — Distribution of Chloride Concentrations in Wells Within the Study Area, May 1976

TABLE 6. — Expected Chloride Concentrations from Wells Throughout the Study Area for the Months of March, July, and September 1975 and May 1976

Study Month	Chloride Concentration in ppm A(50% of Wells ≤)	B(10% of Wells ≥)	Parameters of the Gamma Distribution (Equation 6) a, b
Mar. 1975	205	912	0.6748
July 1975	191	795	0.7252
Sept. 1975	210	778	0.8415
May 1976	208	837	0.7557

The data presented in Table 6 also allow the prediction of the range in chloride concentration and the number of wells within a selected concentration range during any study month. It is assumed that chloride concentrations may range in value between those limits established by those study months fitted to the gamma distribution. The most significant indicator evolving from Table 6 is the value of 912 ppm chloride in column B. If, in fact, 10 percent of the total number of wells in the study area will exceed 912 ppm chloride during the month of March, the total number of wells which may be having a deleterious effect on the ground water resource could number in excess of 120.

REGRESSION ANALYSIS

REGRESSION ANALYSIS

Presented within this section is an expanded discussion on the regression analysis procedure used in the interpretation of chloride data collected during the study period. The condensed version in Technical Report No. 2 can be found in the section "Seasonal Fluctuations in Potentiometric Levels and Chloride Concentrations".

DESCRIPTION OF DATA

The data collected for different analyses presented in this section consist of potentiometric level and chloride concentration on the date of observation, depth of the well, and the depth of aquifer penetration of the well. The observation wells were distributed throughout the study area. However, observations were not made at all wells during all the study months. Depending on field conditions, only the potentiometric level or the chloride concentration could be measured. At some wells, if conditions permitted, additional observations were made during months other than scheduled sample months. The density of all wells in the subareas of the study (Elkton, Hastings, Orange Mills, and Bunnell) is given in Table 7. In the remainder of the study area, the number of observation wells per acre was smaller. The number of observations ranges from 81 to 97 for the months of March 1975, July 1975, September 1975, and May 1976, while only 32 observations were made for September 1976. The areal distribution of the observation wells used in September 1976 differed greatly from other months. Hence, the data for September 1976 were omitted in some statistical analyses.

The range of observed chloride concentration in the five sample months varied from lows of 2 to 10 ppm to highs of 3,260 to 3,410 ppm. However, the number of observations with a chloride concentration greater than 1,000 ppm was

TABLE 7. -- Well Construction Characteristics and Fluctuations of Potentiometric Levels and Chloride Concentration for all Wells Sampled During March 1975 and September 1975

LOCATION	TOTAL ACRES	MEAN WELL DEPTH (FT.)	WELL DENSITY (WELL/ ACRE)	MARCH 1975 MEAN WATER LEVEL (FT.) (MSL)	SEPT. 1975 MEAN WATER LEVEL (FT.) (MSL)	MEAN CHANGE IN WATER LEVEL MAR-SEPT'75 (FT.)	MEAN MAR'75 CHLORIDE VALUE (PPM)	MEAN SEPT'75 CHLORIDE VALUE (PPM)
Elkton Area	6,976	336	1/55	18.65	26.04	+7.39	275	237
Hastings Area	6,336	357	1/27	15.81	17.80	+1.99	696	424
Orange Mills Area	4,673	336	1/33	17.11	21.09	+3.98	513	428
Bunnell Area	27,793	309	1/305	9.29	10.23	+0.94	993	804
Miscellaneous Agricultural Wells *	---	276	---	16.55	22.78	+6.23	249	206
Perimeter Observation Wells *	---		---	30.75	32.58	+1.83	197	226

* See FIGURE 1 for definition of these locations.

not more than five in any month. The distribution of chloride values among the observed wells is shown as a histogram for each of the five study months in Figures 8 through 12.

DESCRIPTION OF ANALYSIS

The dependent or response variable Y (chloride concentration in the present case) may be related linearly to independent variables X_1, X_2, X_3, etc. by the following equation

$$Y = C_o + C_1X_1 + C_2X_2 + C_3X_3 + \dots \quad (1)$$

If Y is related to only independent variable X, and the relation is nonlinear, a higher order polynomial model given by the following equation may be used to describe the relationship between Y and X

$$Y = C_o + C_1X_1 + C_2X^2 + C_3X^3 + \dots \quad (2)$$

The statistical procedures in regression analysis will help to determine (1) the values of C_o, C_1, etc. (called regression coefficients) in Equation 1 or Equation 2; (2) whether Y is significantly related to the independent variables by a relationship like Equation 1 or Equation 2; (3) whether each independent variable in Equation 1, individually or in conjunction with other independent variables, is significantly related to Y, and (4) whether the higher order polynomial terms like X^2, X^3, etc. in Equation 2 are significantly related to Y.

It was assumed that chloride concentration is a function of one or more of the three independent variables; namely, potentiometric level, well depth, and aquifer penetration. Accordingly, regression analyses were performed by

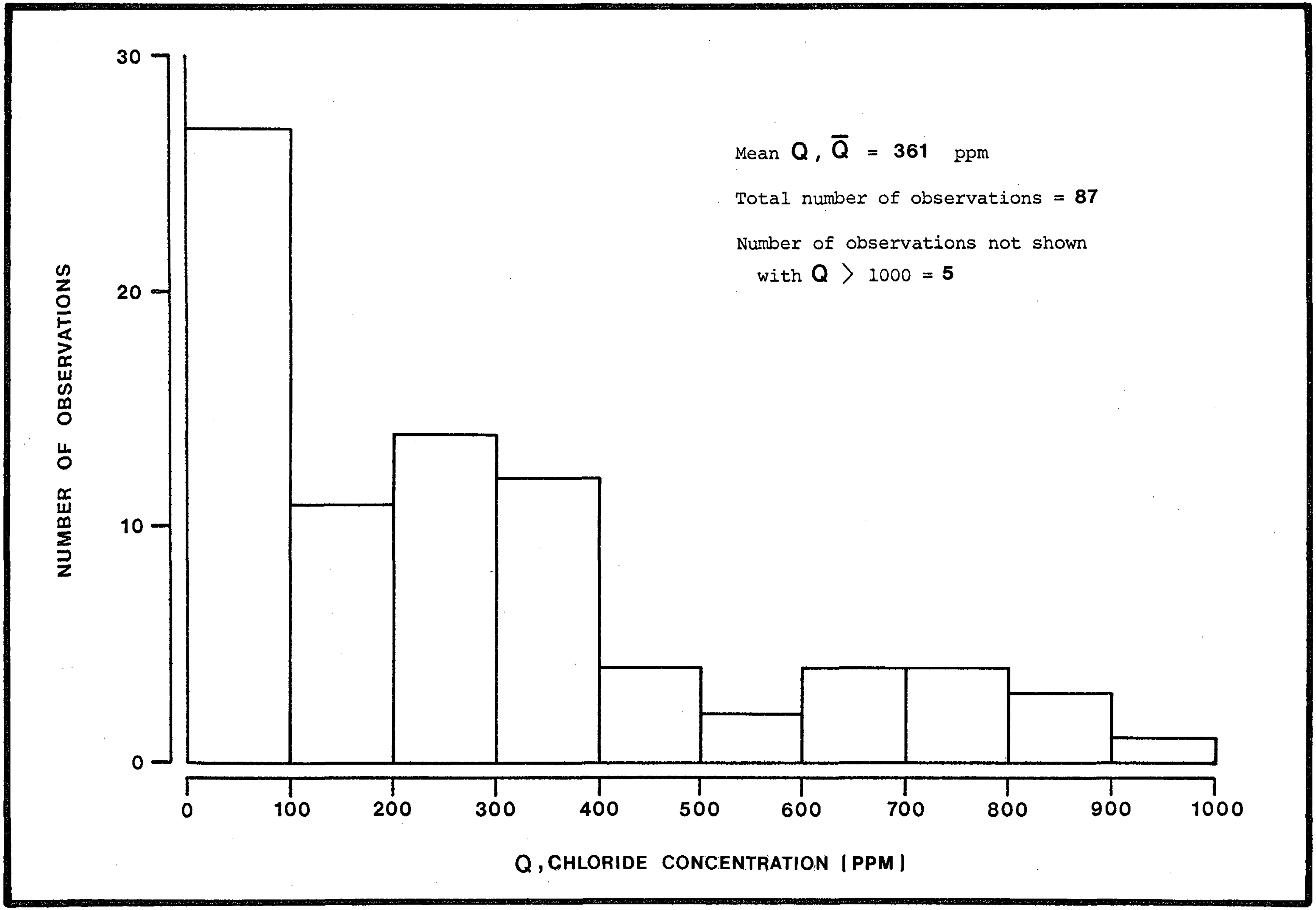


FIGURE 8. -- Histogram of Chloride Concentration in Wells Within the Study Area, March 1975

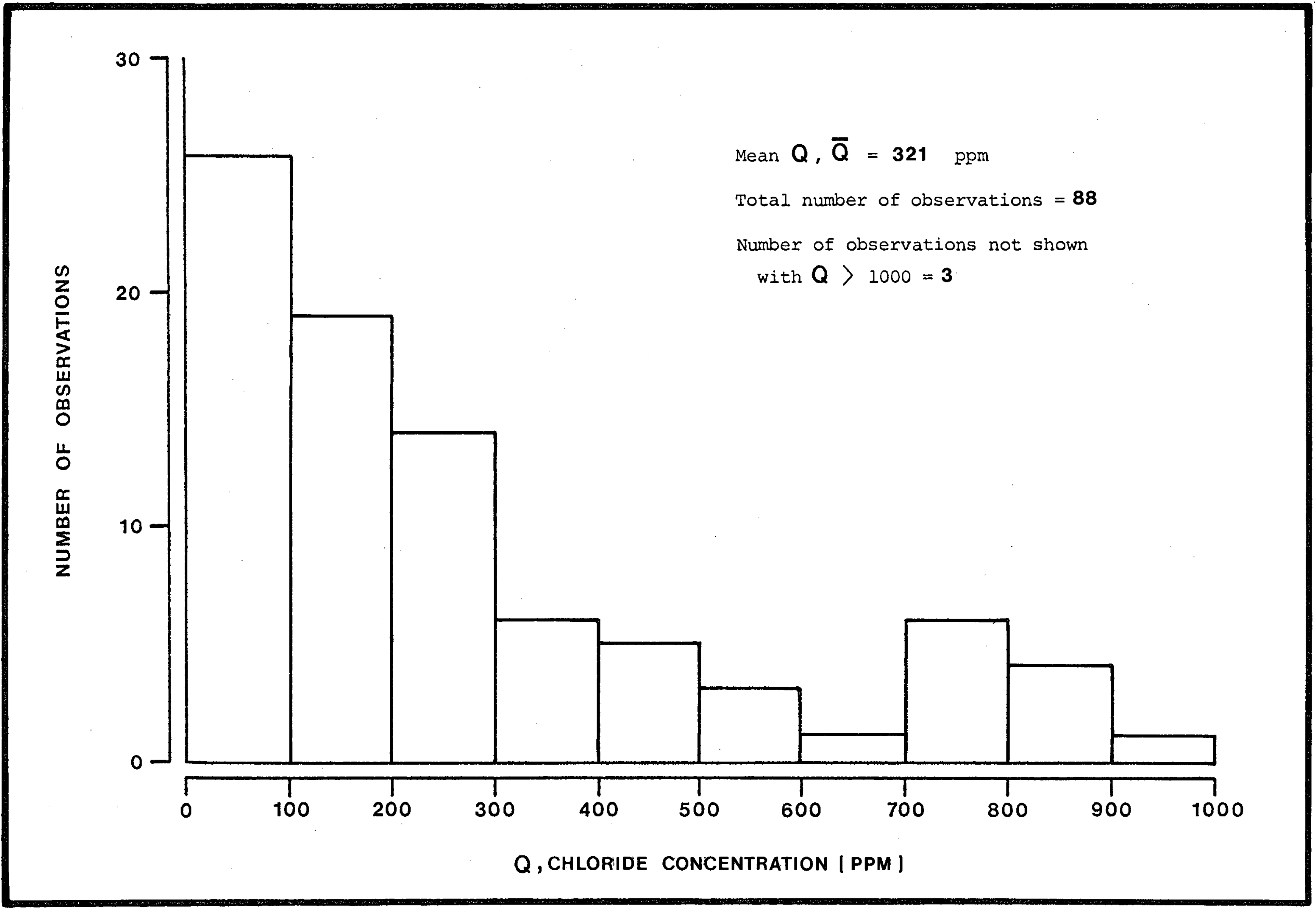


FIGURE 9. -- Histogram of Chloride Concentration in Wells Within the Study Area, July 1975

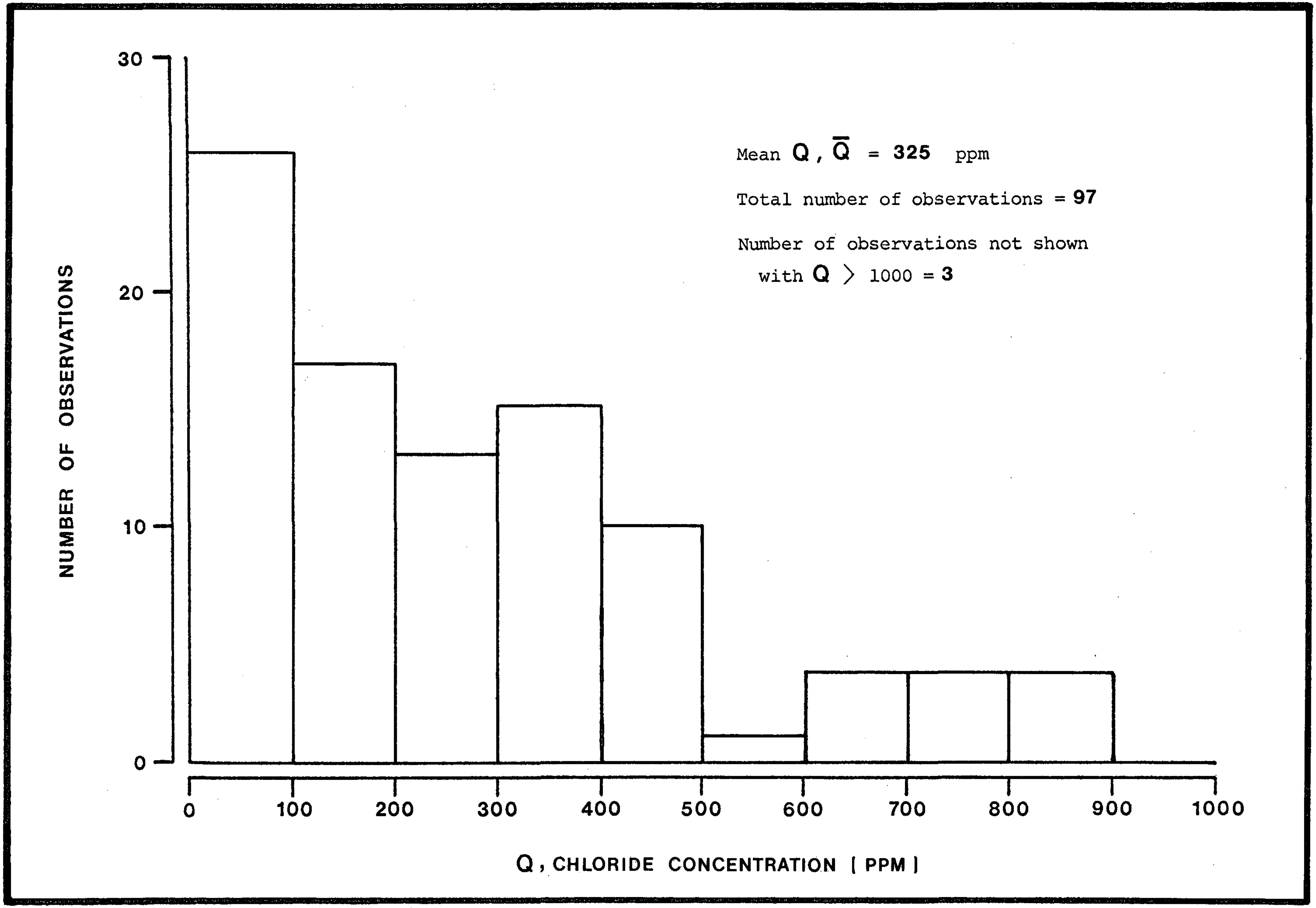


FIGURE 10. -- Histogram of Chloride Concentration in Wells Within the Study Area, September 1975

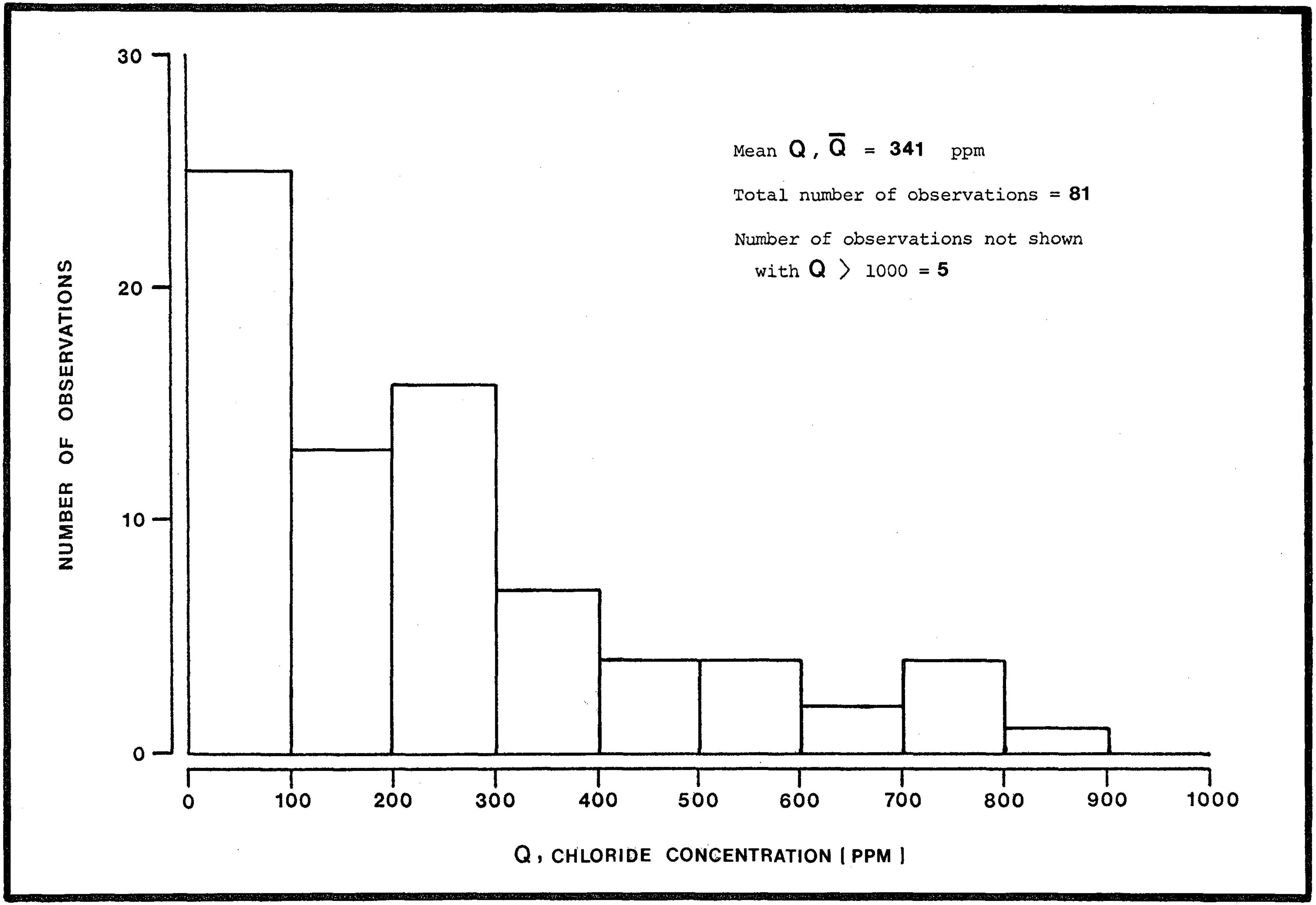


FIGURE 11. -- Histogram of Chloride Concentration in Wells Within the Study Area, May 1976

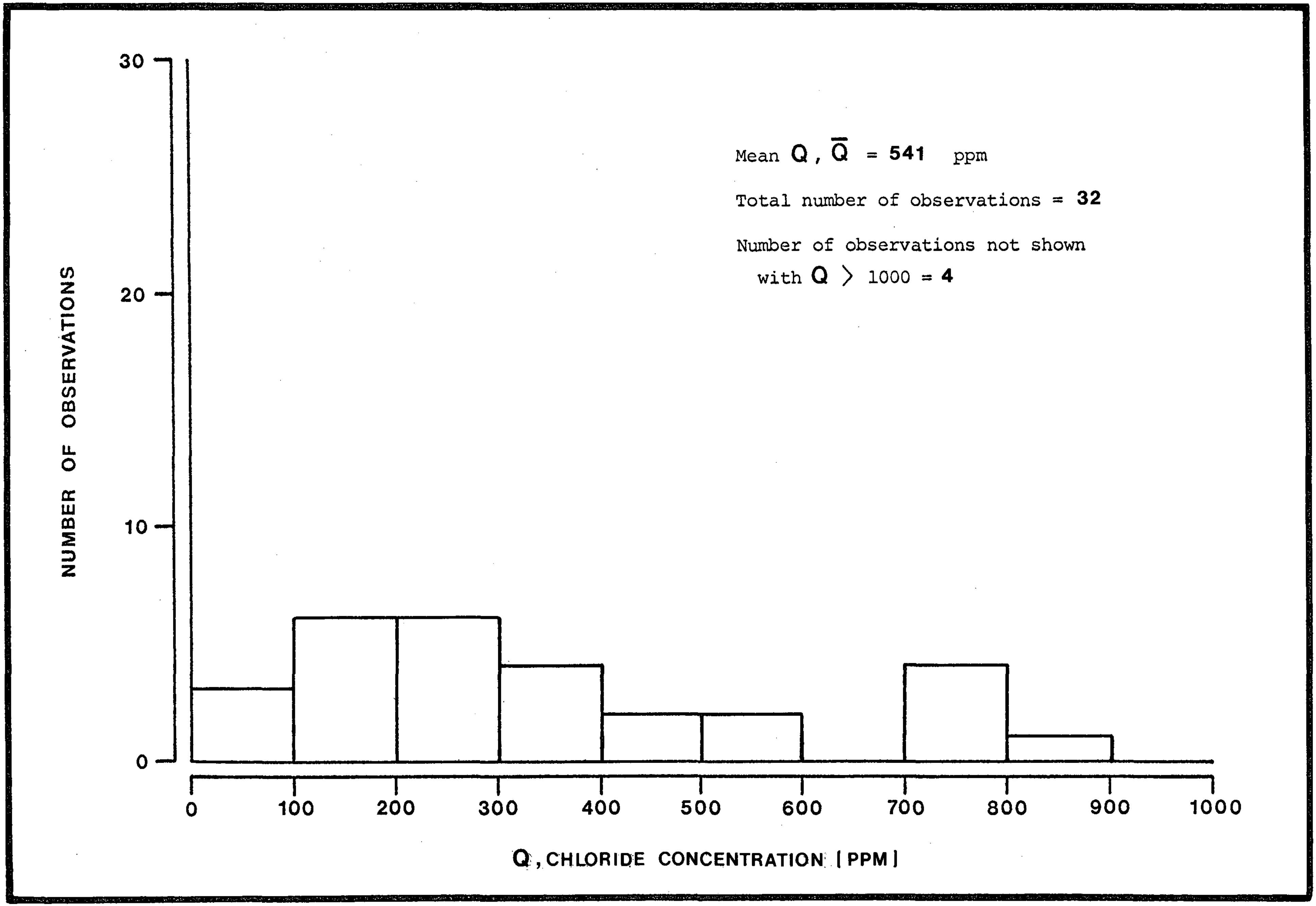


FIGURE 12. -- Histogram of Chloride Concentration in Wells Within the Study Area, September 1976

computer manipulation to determine the relationship between the chloride concentration and the above variables.

The objective of the regression analysis is to determine the 'best' regression equation for the following cases: (1) for each study month for all wells in the study area; (2) a general relationship (all months) for all wells in the study area; (3) for each study month for the wells in each specific study area (Hastings, Elkton, etc.); (4) a general relationship (all months) for the wells in each specific study area; and (5) a general regression equation for individual wells.

The general procedure to determine the 'best' regression equation consists of the following steps:

Let

Y = chloride concentration

X_1 = potentiometric level

X_2 = aquifer penetration of well

X_3 = depth of well

Step 1: Relate linearly

a) Y to X_1

b) Y to X_2

c) Y to X_3

i.e., determine the equations $Y = C_o + C_i X_i$

where

$i = 1, 2, 3$

C_o = the Y intercept

C_i = slope of the line

Based on the value of correlation coefficient (R), determine which X_i ($i = 1$ or 2 or 3) is most closely related to Y.

Step 2: Keeping the X_i that is most closely related to Y in the regression equation, enter a second independent variable into analysis. For example, if X_1 is more closely related to Y in Step 1, determine the following equations:

a) $Y = C_o + C_1X_1 + C_2X_2$

b) $Y = C_o + C_1X_1 + C_3X_3$

Note if there is any improvement in the correlation coefficient R.

Step 3: Relate to X_1, X_2, and X_3, i.e., determine the following equation:

$$Y = C_o + C_1X_1 + C_2X_2 + C_3X_3$$

Note the improvement in the correlation coefficient.

In each step, test if Y is significantly related to X_i's. If it is found that Y is not significantly related to X_i's in any step, further analysis may be abandoned.

The selection of 'best' regression equation will be based on the improvement seen in the value of correlation coefficient (R) when more X_i's are entered into the analysis. If there is no significant improvement in the value of R between Step 2 and Step 3, then it will be concluded that only two X_i's are closely related to Y.

RESULTS

Case 1. Regression Equations for each Study Month for all Wells in the Study Area

First, Y was regressed on X_1, X_2, and X_3 separately. The statistical tests of significance showed that Y was significantly related to X_1, but not to X_2 or X_3.

Next, Y was regressed on X_1 and X_2 and on X_1 and X_3. The regression equations were found to be significant, but no substantial improvement was noticed in the values of R due to the addition of a second independent variable in regression (Table 8).

Finally, Y was regressed on X_1, X_2, and X_3. Again, the regression was found to be significant, but no improvement was noticed in the value of R due to inclusion of X_3 in the regression.

The values of R ranged from 0.4444 to 0.4808 for simple linear regression (Y on X_1), and 0.4735 to 0.5201 for multiple regression (Table 9). These low values of R against a desired value of 0.9 or greater indicate that although chloride concentration is significantly related to potentiometric level or aquifer penetration of well and depth of well in conjunction with potentiometric level, these independent variables as a group do not substantially account for chloride concentration in water pumped in different locations in the study area.

Regression analyses were also performed using a higher order polynomial model (Equation 2) with the potentiometric level as the polynomial, X. However, the quadratic and cubic models were not found to be better than the linear models as indicated by the values of R (Table 9).

The regression equations in the form of

$$Y = C_o + C_1X$$

where

X = potentiometric level
Y = chloride concentration
C_o = the Y intercept
C_1 = slope of the line

TABLE 8. -- Values of Correlation Coefficient in Linear Regression Analysis (All Wells in Area)

Y (chloride concentration) is linearly related to

Study Month	X_1	X_1 and X_2	X_1 and X_3	X_1, X_2, and X_3	Remarks
Mar. 1975	0.4444	0.4762	0.4735	0.4771	Case 1
July 1975	0.4589	0.5026	0.4975	0.5026	Case 1
Sept. 1975	0.4808	0.5198	0.5125	0.5201	Case 1
May 1976	0.4516	0.4828	0.4860	0.4840	Case 1
All above	0.4160	0.4223	0.4253	0.4273	Case 2

where: X_1 = potentiometric level

X_2 = aquifer penetration of well

X_3 = depth of well

TABLE 9. -- Values of Correlation Coefficient in Regression With Higher Order Polynomial Models (All Wells in Area)

Form of the Model

Study Month	$Y=Co+C_1X$	$Y=Co+C_1X+C_2X^2$	$Y=Co+C_1X+C_2X^2+C_3X^3$
Mar. 1975	0.4444	0.4953	0.5001
July 1975	0.4589	0.5024	0.5029
Sept. 1975	0.4808	0.5283	0.5294
May 1976	0.4516	0.5149	0.5306

where: Y = chloride concentration

X_1 = potentiometric level

X_2 = aquifer penetration of well

X_3 = well depth

are shown in Table 10 for the four study months--March 1975, July 1975, September 1975, and May 1976. No equation was determined for the study month of September 1976.

Case 2. A General Regression Equation for all Wells in the Study Area

For this purpose, data of all four study months of Case 1 were combined and regression analyses performed. However, use was made of only those observations for which the values of Y, X_1, X_2, and X_3 were available.

Y was linearly regressed on (X_1), (X_1, X_2), (X_1, X_3), and (X_1, X_2, X_3). The values of R are summarized in Table 2.

As in Case 1, the multiple regression models did not show any superiority over simple regression model as indicated by the values of R. The simple linear model, $Y = C_o + C_1X$, is shown in Table 9 for this case.

Case 3. A Regression Equation for Each Study Month for the Wells in Each Specific Study Area

For this purpose, regression analyses were performed using data collected from the wells of each area (Hastings, Orange Mills, Bunnell and Elkton) during each study month. The number of observations due to such disaggregation of data ranged from 0 to 17. Of the 20 cases (5 months x 4 areas), nine cases had less than five observations available. Y was regressed on X_1 for the remainder of the cases. For all except one case (Orange Mills area - May 1976), the regression was found to be 'not significant'.

More data may be necessary to establish regression equations under this case.

Case 4. A General Regression Equation for the Wells in Each Specific Study Area

For this purpose, regression analyses were performed using data collected during all study months from the wells in each specific area. Y was regressed on X_1, and the regression was found to be significant for Hastings, Orange Mills, and Bunnell areas. The results of the analysis are summarized in Table 11 and illustrated in Figure 13.

Case 5. Regression Equations for Individual Wells

The number of observations made from any individual well during the study period (March 1975 to September 1976) ranged from 3 to 10. Regression analyses (chloride concentration on potentiometric level) were performed for all wells for which the number of observations available was greater than or equal to five. There were 44 such wells in the study area, and regression was found to be significant in 11 wells (Table 12). For these wells, the value of R ranged from 0.6425 to 0.9574, a significantly large value compared to the values found in the foregoing cases.

A final note on the use of regression equations derived in this study: The values of the correlation coefficients (R) for the regression equations derived for the cases 1, 2, and 4 were very low compared to a desired minimum value of 0.9. Hence, chloride values based on these equations will be very approximate; and therefore, these equations may not be used except for obtaining a rough estimate of the chloride concentrations in the study area.

TABLE 10. -- The 'Best' Regression Equations
(All Wells in Area)
(X = Potentiometric Level)

Study Month	No. of Observations	Regression Equation	Remarks
Mar. 1975	75	y=847.77-22.03x	Case 1
July 1975	84	y=818.64-21.91x	Case 1
Sept. 1975	95	y=844.41-22.21x	Case 1
May 1976	78	y=875.49-24.40x	Case 1
All above	332	y=846.13-22.82x	Case 2

TABLE 11. -- Results of Regression Analysis for
Different Study Areas
(X = Potentiometric Level)

Study Area	No. of Observations	Regression Equation	Correlation Coefficient
Hastings	76	y=2042.34-89.88x	.3881
Orange Mills	88	y=1095.30-33.23x	.4118
Bunnell	39	y=1046.85-24.72x	.3709
*Elkton	10	--------	---

*Insufficient Data Points

TABLE 12. -- RESULTS OF REGRESSION ANALYSIS FOR INDIVIDUAL WELLS
(Chloride Concentration vs. Water Level)

Local Well No.	Correlation Coefficient (R)	Goodness of Fit (R^2)	F Statistic	Degrees of Freedom	Remarks*
Bu 66	.05	.0025	.0176	8	X
101	.7079	.5011	6.0261	7	S
126	.3267	.1067	.8365	8	X
133	.5617	.3155	1.3826	4	X
El 267	.4938	.2438	.9673	4	X
286	.0965	.0093	.0282	4	X
388	.2729	.0745	.2414	4	X
Ha 31	.7469	.5620	7.6975	7	S
76	.8706	.7579	9.3913	4	S
226	.6440	.4148	4.2526	7	X
263	.8671	.7518	15.1451	6	S
378	.9574	.9166	43.9410	5	S
Or 68	.9202	.8467	16.5743	4	S
69	.9286	.8623	18.7889	4	S
77	.2095	.0439	.3215	8	X
107	.4983	.2483	2.3120	8	X
178	.4809	.2313	1.8053	7	X
333	.6346	.4024	4.7187	8	X
Pe 2	.0229	.0005	.0016	4	X
3	.1714	.0294	.0908	4	X
4	.0124	.0002	.0006	5	X
20	.0989	.0098	.0296	4	X
134	.6425	.4128	5.6245	9	S
290	.6648	.4420	4.7523	7	X
306	.1398	.0196	.0598	4	X
401	.7814	.6105	4.7023	4	X
413	.5489	.3013	1.2935	4	X
416	.5951	.3541	1.6450	4	X
418	.0153	.0002	.0007	4	X
422	.7953	.6324	5.1617	4	X
427	.8167	.6670	6.0102	4	X
432	.5677	.3223	3.8047	9	X
433	.8764	.7681	9.9364	4	S
436	.0392	.0015	.0046	4	X
438	.1668	.0278	.0858	4	X
Mi 10	.7972	.6355	8.745	6	S
26	.5437	.2956	2.9377	8	X
76	.6248	.3904	1.9210	4	X
92	.8820	.7780	10.5124	4	S
108	.2207	.0487	.3583	8	X
111	.3188	.1017	.5658	6	X
133	.1083	.0117	.0712	7	X
395	.3112	.0968	.3217	4	X

*S = Regression significant
X = Regression not significant

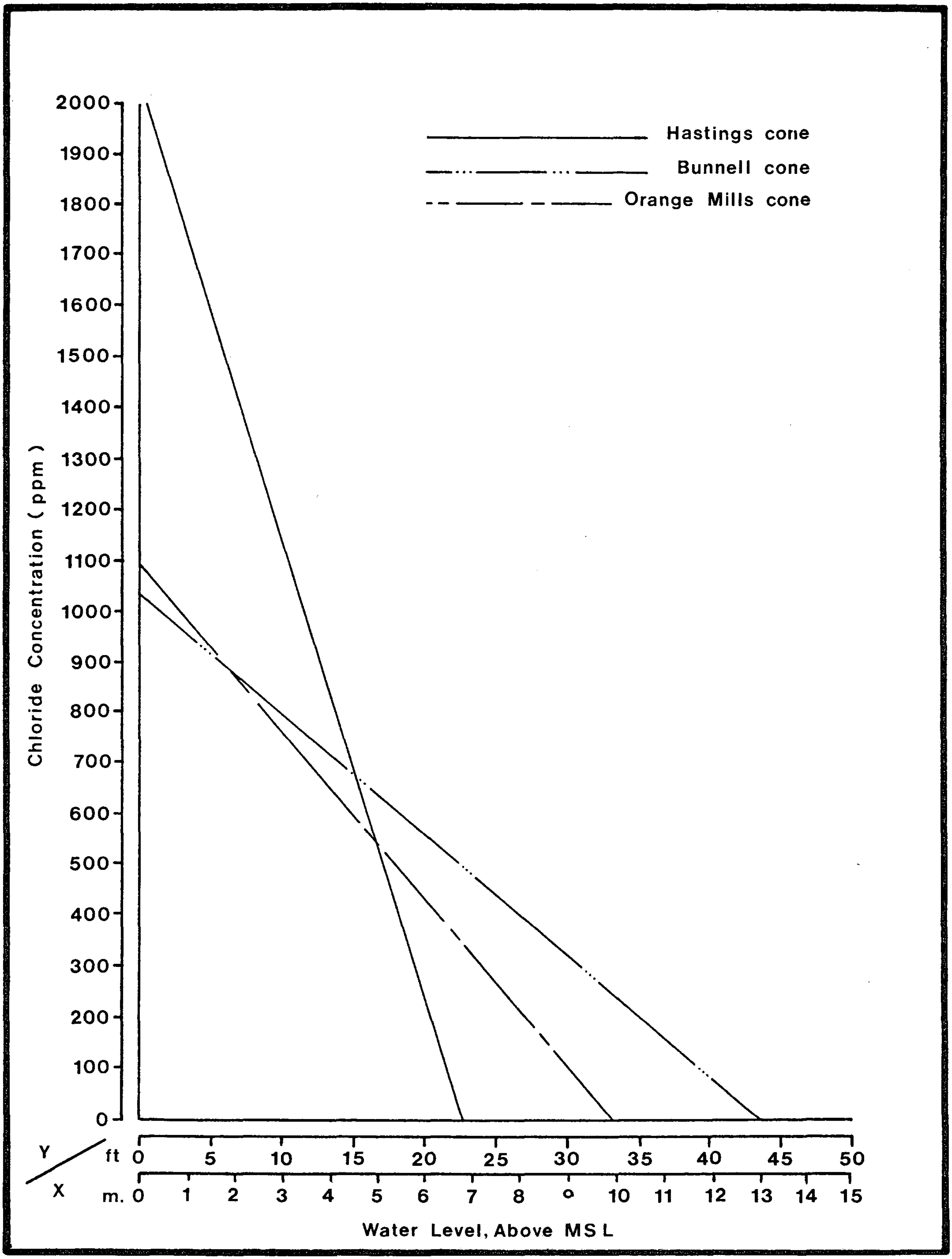


FIGURE 13. -- Derived Linear Equations of All Data From Individual Areas

METHODS FOR ESTIMATING GROUND WATER WITHDRAWALS

METHODS FOR ESTIMATING GROUND WATER WITHDRAWALS

This section conveys in general terms a method by which an agriculturalist may catalog his own water use during the year. Emphasis will be placed on three items: pump discharge rating, electrical rating, and the calculation of water use.

METHODS OF MEASURING DISCHARGE

There are three general categories which will be discussed in this section: volumetric measurement, direct discharge measurement (open pipe), and the use of meters. The method which is the best for individual pumping stations depends on existing conditions at the station and the type of irrigation system used.

Volumetric Flow Measurement

In this method, open discharge from a pump is calculated by observing the amount of time required to fill a container of known quantity (20-gallon can, 55-gallon drum, fertilizer tank, etc.). The following formulas can then calculate discharge for the various types of irrigation systems used:

$$Q \text{ (gallons per minute)} = \frac{\text{Volume of container (gallons)} \times 60}{\text{Time required to fill container (seconds)}}$$

This method can also be utilized in the measurement of discharge into furrows by closed-system PVC installations when all discharging lines have been equally valved. In this case, discharge into one furrow can be measured, and the discharge applied to the field can be calculated as follows:

$$\begin{array}{l}\text{Total average discharge}\\ \text{applied to the field (gpm)}\end{array} = \frac{\text{Volume of container (gallons} \times 60 \times \text{number of furrows)}}{\text{Time required to fill container (seconds)}}$$

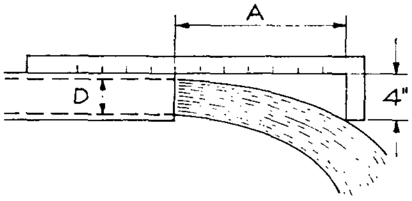
This same method can also be used in an open system if furrow tubes are used and installed properly. The same formula should be used in this calculation, although this calculation underestimates actual water pumped due to seepage and evaporation losses in the header ditch. If measurements are not possible in the field, then discharge should be measured at the pump.

Direct Discharge Measurement

This method may be used where there is open discharge from a pump. The table provided below (Jacuzzi) gives discharge (Q) values for various size pipes. Measurement of the specific lengths, as shown in the chart below (Table 13), may be done with a simple carpenter's rule.

ESTIMATING the OUTPUT from a PIPE by the horizontal open discharge method

TABLE 13. -- (FULL PIPES)



Construct an L-shaped gauge like that shown above, with the short leg 4 inches long. Make the long leg to suit the pipe sizes and capacities for which the gauge will be used (refer to table), and mark it in inches.

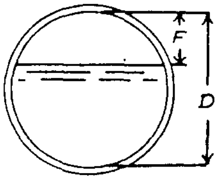
Lay the gauge along the top of the pipe with the short leg barely touching the stream of water, and note distance **A**. Read the discharge rate from the table.

EXAMPLE.
D = 3"; **A** = 15" : **Q** = 183 gpm

Table is based on formula:
$Q = 1.28 \times A \times (D)^2$

A inches	1"	1¼"	1½"	2"	2½"	3"	4"	5"	6"	8"	10"	12"
	NOMINAL SIZE of PIPE (D) — DISCHARGE RATE (Q) — Gallons per MINUTE											
4	5.7	9.8	13.3	22.0	31.3	48.5	83.5					
5	7.1	12.2	16.6	27.5	39.0	61.0	104	163				
6	8.5	14.7	20.0	33.0	47.0	73.0	125	195	285			
7	10.0	17.1	23.2	38.5	55.0	85.0	146	228	334	580		
8	11.3	19.6	26.5	44.0	62.5	97.5	166	260	380	665	1060	
9	12.8	22.0	29.8	49.5	70.0	110	187	293	430	750	1190	1660
10	14.2	24.5	33.2	55.5	78.2	122	208	326	476	830	1330	1850
11	15.6	27.0	36.5	60.5	86.0	134	229	360	525	915	1460	2020
12	17.0	29.0	40.0	66.0	94.0	146	250	390	570	1000	1600	2220
13	18.5	31.5	43.0	71.5	102	158	270	425	620	1080	1730	2400
14	20.0	34.0	46.5	77.0	109	170	292	456	670	1160	1860	2590
15	21.3	36.3	50.0	82.5	117	$\boxed{183}$	312	490	710	1250	2000	2780
16	22.7	39.0	53.0	88.0	125	196	334	520	760	1330	2120	2960
17		41.5	56.5	93.0	133	207	355	550	810	1410	2260	3140
18			60.0	99.0	144	220	375	590	860	1500	2390	3330
19				110	148	232	395	620	910	1580	2520	3500
20					156	244	415	650	950	1660	2660	3700
21						256	435	685	1000	1750	2800	3890
22							460	720	1050	1830	2920	4060
23								750	1100	1910	3060	4250
24									1140	2000	3200	4440

(PARTIALLY FILLED PIPES)



For partially filled pipes, measure the freeboard (F) and the inside diameter (D) and calculate the ratio of F/D (in percent). Measure the stream as explained above for full pipes and calculate the discharge. The actual discharge will be approximately the value for a full pipe of the same diameter multiplied by the correction factor from the following table:

F/D Percent	Factor	F/D Percent	Factor	F/D Percent	Factor	F/D Percent	Factor
5	0.981	30	0.747	55	0.436	80	0.142
10	.948	35	.688	60	.375	85	.095
15	.905	40	.627	65	.312	90	.052
20	.858	45	.564	70	.253	95	.019
25	.806	50	.500	75	.195	100	.000

Water Meter

There are several in-line water meters which give a numerical readout. This type of equipment is priced from $400 and would be useful in the closed-system PVC installations or mounted on the discharge side of the pump in an open system for measuring cumulative totals of ground water withdrawals during the year.

ELECTRICAL CONSUMPTION OF IRRIGATION PUMPS

The purpose of this section is to give the agriculturalist a way of determining monthly and annual ground water withdrawals utilizing the electrical consumption (kilowatt-hour values) method. During the year, power consumption may change due to variables such as water levels and pump efficiency which affect a pump's performance. Ratings on the pumps for discharge and electrical consumption should be made at least twice during the growing season in order to make a more reliable determination of withdrawal rates. In some cases, it will be necessary for an individual to calculate electrical consumption if the graphs provided in the report do not apply. The method of calculating power from watt-hour meters is relatively simple and can be done with a fair amount of accuracy in the field.

Where electrical power is provided for irrigation pumps, an electric meter is installed. By observing the amount of time it takes for the internal disc of the electric meter to revolve, kilowatt input to pumping plants can be determined by the following formula (Anderson, 1973, p. 140):

$$KW = 3.6 \times K^* \times \frac{R}{T}$$

where:

KW = Kilowatts

K = Disc constant

R = Revolutions of Disc

T = Time recorded for observed revolution, in seconds

*Disc constants are signified by the "Kh" value stamped on the face plate.

Once the kilowatt input has been determined and pump discharge has been measured, Total Dynamic Head (TDH) can then be calculated (SCS, Chapter 9, 1962). Total Dynamic Head (TDH) is the vertical distance from the center of the pump to the water level in the well during pumping plus the total dynamic discharge head (pressure at discharge x 2.31 feet per square inch) less the suction head velocity which is almost negligible.

$$TDH = \frac{KW \times Eff \times 3960}{GPM \times .746}$$

where:

TDH = Total Dynamic Head (ft.)

KW = Kilowatt input

Eff = Efficiency of pumping system, taking into consideration pump efficiency and electric motor efficiency (percent)

GPM = Discharge of the pump system (gallons per minute)

Efficiency of the pumping system is an important factor in terms of production. In developing the rating graphs in the statistical section, 60 percent efficiency was assumed for all pumping systems. The practical operating range for efficiencies is from 50 to 87 percent, depending upon the condition of the pump and well.

Once the agriculturalist has taken the time to calculate kilowatt input and TDH, he can derive a kilowatt-hour (KWH) per 1,000 gallons of water pumped value for the pumping system by the following formula (SCS, Chapter 9, 1962):

$$\text{KWH per 1,000 gallons pumped} = \frac{\text{TDH} \times .00314}{\text{Eff}}$$

Eff = Efficiency of the pumping system (percent)

TDH = Total Dynamic Head (ft.)

Taking the above information one step further, values for the quantities of thousand gallons of discharge are obtained by dividing the monthly kilowatt-hour usage by the calculated KWH per 1,000 gallon value.

EXAMPLE

An individual has a 4-inch well with a 5-horsepower centrifugal pump which has been rated in the field to produce 240 gpm. During the month of January, this pump consumed 2,300 KWH of electricity. Determine the total amount of gallons of water pumped during that month.

Step 1: Determine the Kilowatt input to the pump from the watt hour meter.

a. Locate the Disc Constant on the meter usually marked "Kh". On this particular meter, the "Kh" was rated 7.2.

b. Time and record the amount of seconds it takes for the revolving disc to make one revolution. The disc was timed at 8.0 seconds.

c. Substitute the observed values in the following equation:

$$Kw = 3.6 \times \text{"Kh"} \times \frac{R}{T}$$

where:

Kw = Kilowatt

"Kh" = Disc constant

R = Revolution of the Disc

T = Time recorded for observed revolution(s), in seconds

for the hypothetical problem described

$$Kw = 3.6 \times 7.2 \times (1/8)$$

$$Kw \text{ input} = 3.24$$

Step 2: Determine the TDH for the irrigation system by the following equation:

$$\text{TDH} = \frac{\text{Kw x Eff x 3960}}{\text{GPM x .746}}$$

where:

TDH = Total Dynamic Head, in feet

Kw = Kilowatt input, as calculated from Step 1

Eff = Efficiency of pumping system, usually estimated at 60% or .60

GPM = Discharge in gallons per minute, as rated in the field

a. Substitute the values in appropriate places.

$$\text{TDH} = \frac{3.24 \text{ x } .60 \text{ x } 3960}{240 \text{ x } .746}$$

$$\text{TDH} = \frac{7698.24}{179.04}$$

TDH = 42.99 feet

Step 3: Determine the Kilowatt-hour(KWH) per 1,000 gallon value for that irrigation system by the following equation:

$$\text{KWH/1,000 gallons} = \frac{\text{TDH x .00314}}{\text{Eff}}$$

where:

TDH = Total Dynamic Head, in feet

Eff = Efficiency of irrigation system, in percent

Step 3 (continued):

a. Substitute the values in the appropriate places.

$$\text{KWH/1,000 gallons} = \frac{42.99 \times .00314}{.60}$$

$$\text{KWH/1,000 gallons} = 0.225$$

Step 4: Determine amount of water pumped during the month of January by dividing the monthly KWH usage (2,300 KWH) by calculated KWH/1,000 gallon value (.225).

$$\text{Thousand gallons of water pumped} = \frac{\text{Monthly KWH Usage}}{\text{(KWH/1,000 gallon value)}}$$

$$\text{Thousand gallons of water pumped} = \frac{2300}{.225}$$

$$\text{Thousand gallons of water pumped} = 10{,}222$$

$$\text{Gallons of water pumped} = 10{,}222{,}000$$

UTILIZATION OF RATING GRAPHS DEVELOPED BY THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

This section will provide a step by step procedure for estimating ground water withdrawal from specific pumping systems, similar to the previous section, but with very little mathematical calculation. The graphs were synthesized from field data collected in the agricultural area of St. Johns, Putnam, and Flagler counties. This data is only relevant to these areas and only gives an estimate of ground water withdrawals in which electrical pumping systems were used.

Step 1: As done in the previous section, discharge capacity (gpm) of the pump must be rated and the electric motor horsepower should be recorded.

Step 2: Using Figure 14 which illustrates the general trend of the relationship between discharge and kilowatt input of field data collected during this project, locate the GPM of the pump system on the vertical axis and proceed horizontally across to the point of intersection on the trend line. Then drop straight down to the horizontal axis and read the kilowatt input value.

Step 3: Referring back to the equation for the calculation of TDH, substitute

$$TDH = \frac{KW \times Eff \times 3960}{GPM \times .746}$$

into that equation the field measured value of discharge (GPM) and the KW value derived from the appropriate figure in Step 2. The efficiency value (decimal unit) selected by the agriculturalist represents the relative performance of the pumping system. Older installations usually run in the 50-60 percent range. Recently rebuilt motors and pumps may run in the 70-80 percent range. New installations will operate in the 80 percent range. If there is relatively no information about the system available, use the 70 percent value (Johnson, 1975).

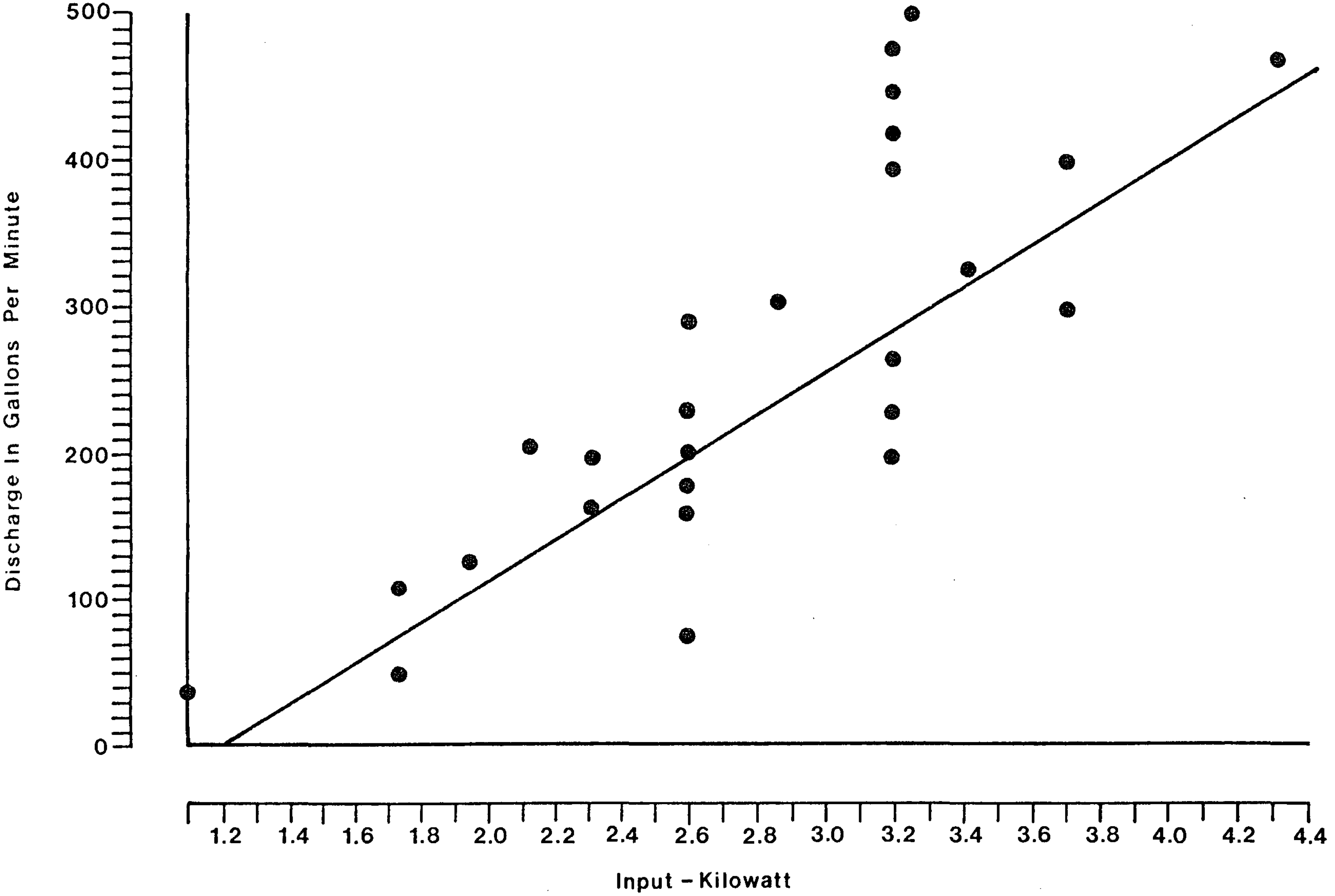


FIGURE 14. -- Generalized Trend of the Relationship Between Discharge and Kilowatt Input for Centrifugal Pumps Inventoried in the Tri-County Area

Step 4: Once TDH has been calculated, the KWH/1,000 gallons value can be determined by locating the TDH on the vertical axis of Figure 15, and by moving horizontally across to the designated efficiency line, then drop directly down and read the KWH/1,000 gallons value.

Step 5: Knowing the monthly kilowatt-hour usage, it is then possible to determine ground water withdrawals from that pump by simply dividing KWH used by KWH/1,000 gallons value read from the graph, and then multiply by 1,000 to calculate gallons of water pumped for that month.

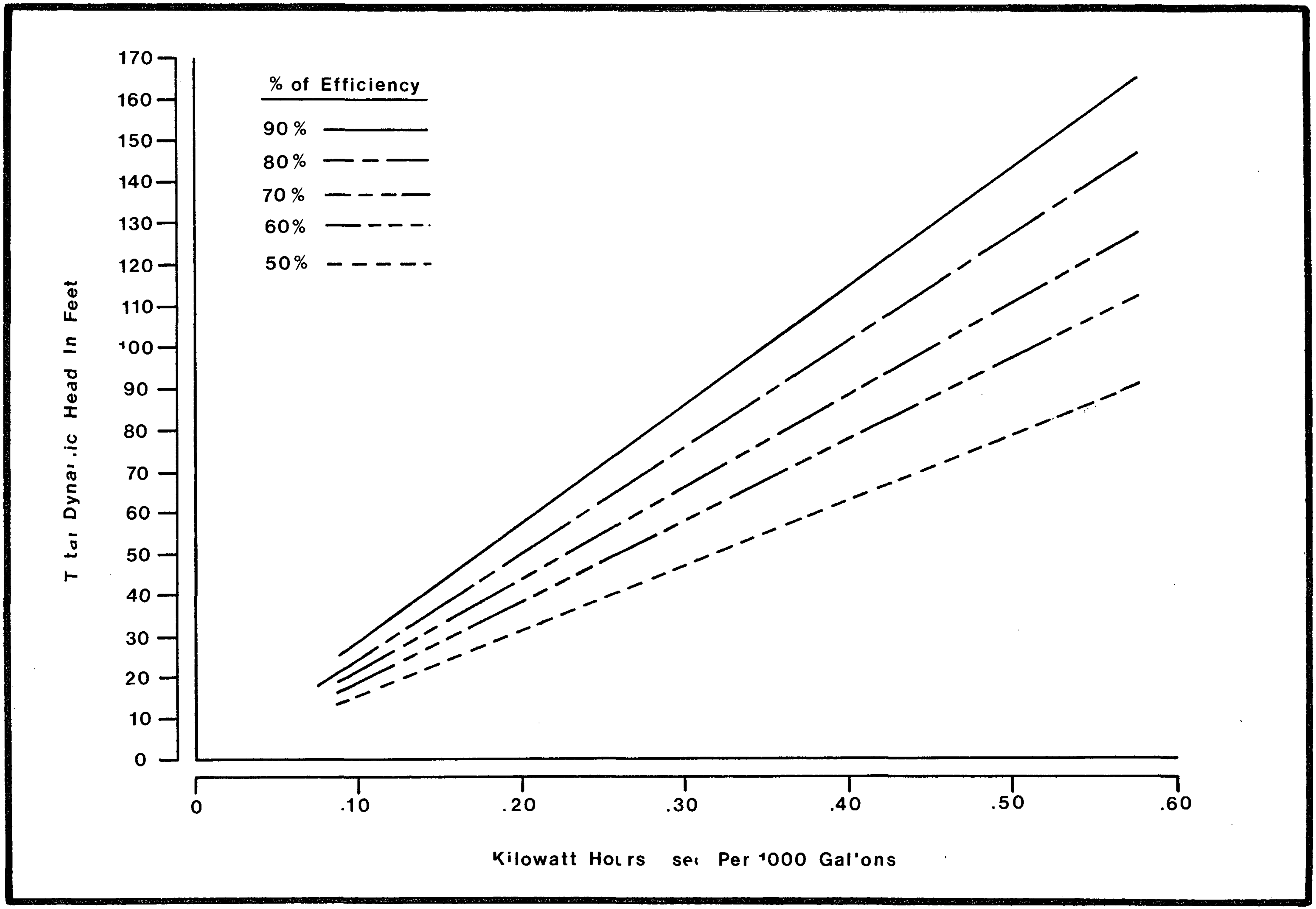


FIGURE 15. -- Estimation of KWH/1,000 Gallons of Water Pumped Values From Total Dynamic Head Values at Various Efficiency Ratings

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