HYDROLOGIC MONITORING FOR SHIRLEY BASIN'S TAILINGS SEEPAGE CONTROL PLAN

PREPARED FOR:

PATHFINDER MINES CORPORATION

PREPARED BY:

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1.0 SUMMARY AND INTRODUCTION

1.1 SUMMARY

1. The recharge lines and fresh water injection wells have created hydrologic mounds in the Surficial aquifer that have caused seepage gradient reversal toward the collection wells, as originally intended. The gradient reversals can be measured along the northeastern and southeastern length of the Surficial aquifer where tailings seepage is primarily occurring. Reversal in this area has been enhanced by the use of water from wells WW20 and WW23 (see Section 3). Gradient reversal was restored in late 1997 and was maintained through 2001.

2. Concentrations of seepage constituents in the Surficial aquifer in the Mine Creek area have improved upgradient of the recharge lines north and south of Mine Creek. Gradient reversal was maintained for the immediate Mine Creek area and north of Mine Creek during 2001. There was no substantial change in restoration for these areas during 2001. The seepage front has been pulled back to close proximity to the collection wells and the collection/recharge system is functioning as a seepage containment system.

3. Surface water monitoring in Spring Creek does not indicate measurable environmental impact from tailings seepage in 2001 because of improvement of water quality in the Surficial aquifer. Comparative data are included in Section 5.0.

4. White River aquifer monitoring continues to indicate no impacts that can be attributable to tailings seepage (see Section 6.0). However, current and previous years' monitoring data from well WH-9 has shown elevated TDS, Cl and SO_4 concentrations. This is thought to be a localized phenomenon.

5. The 2001 enhanced evaporation system consisted of about 300 evaporative heads and 19 acres of solution ponds, resulting in a net loss of about 39 million gallons of ponded solution and moderate progress in tailings dewatering (see Section 8). All transferable water on the tailings surface has been moved to the new evaporation ponds in the northwestern part of Tailings Pond No. 5.

6. Additional tailings dewatering wells were installed in the spring of 1997 and during the winter 1998/1999. The dewatering of tailings is proceeding and will facilitate consolidation and reduce seepage. Tailings Pond No. 4 and Pond No. 5 are showing appreciable reductions in water levels due to dewatering.

7. Surficial collection wells near the center of the tailings impoundment are being pumped. Extraction of the seepage-impacted water beneath the tailings reduces the migration of contaminants beyond the tailings area.

8. A significant portion of the Surficial collection water has been separated and discharged to the Area 2/8 reservoir. This has been done with rigorous monitoring of the water quality of the discharge.

1.2 INTRODUCTION

Figure 1.2-1 presents the major tailings area features. These include the Mine Creek area, where the original recharge and collection systems were installed. The recharge system, installed during the summer of 1986, was constructed to supply water to insure continuous seepage gradient reversal in the Mine Creek area (see Figure 1.2-1). This has been accomplished and continues to contain tailings seepage close to the downgradient edge of the No. 5 tailings dam on the southeast end. Subsequent additions and modifications to the seepage containment and aquifer restoration system have continued restoration efforts in the Mine Creek area, and expanded the restoration effort to the entire tailings area. A number of reports have already been prepared and submitted to the NRC which document the purposes and development of the recharge and collection system. This is the latest in this series of reports, which is provided in accordance with SUA-442, Condition 47. The NRC site standards for thirteen constituents are presented in Table 1.2-1.

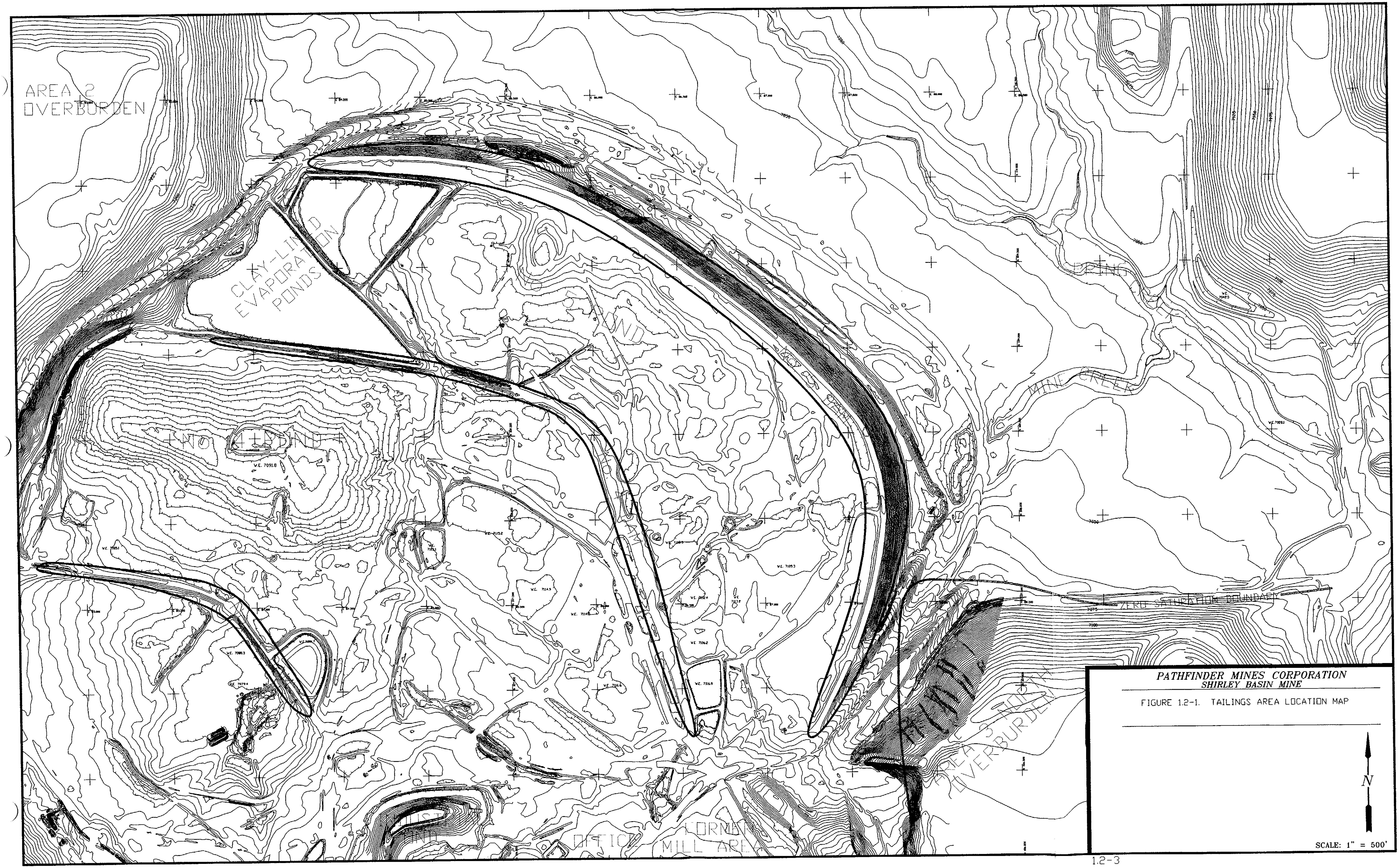
This report is divided into eight main sections. Section 2 discusses the Mine Creek area pumping operations. Sections 3, 4, 5, and 6 discuss various monitoring results. Section 7 addresses recent additions and modifications to the seepage containment and aquifer restoration system. Section 8 addresses tailings dewatering and evaporation of tailings solution. Section 9 addresses recommendations for continued aquifer restoration. Appendix A presents a tabulation of Surficial water quality data. Appendix B presents a tabulation of White River, Wind River, and Tailings water quality data. Appendix C presents a tabulation of Surface water quality data.

Pending approval of ACL's, Pathfinder will continue to monitor the efficiency of the recharge system and compile annual reports. These reports will document the previous years' results and describe any modifications to the system necessary to improve the system's performance.

TABLE 1.2-1. SHIRLEY BASIN NRC SITE STANDARDS.

CONSTITUENTS	NRC SITE STANDARD
ARSENIC	0.05
BARIUM	1.0
BERYLLIUM	0.02
CADMIUM	0.01
CHROMIUM	0.05
GROSS ALPHA	15
LEAD	0.05
MOLYBDENUM	0.1
NICKEL	0.05
RADIUM-226 + RADIUM-228	5.0
SELENIUM	0.01
THORIUM-230	0.3
URANIUM	0.07

NOTE: All concentrations are in mg/l except:
Radium-226 + Radium-228, Gross Alpha and Thorium-230 are in pCi/l.



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SHIRLEY BASIN MINE

FIGURE 1.2-1. TAILINGS AREA LOCATION MAP

2.0 MINE CREEK AREA PUMPING OPERATIONS

2.1 COLLECTION WELL PUMPING

Nineteen pumpback (collection) wells, 5A-1, P1, P3, P4, P7, P6, P8A, P9, P10, P11, P12, P14, P15, P16, P17, P18, P19A, P20 and P21, were pumped during 2001. Table 2.1-1 shows the recommended water levels, locations of the pump intakes, and average discharge rates for each pumpback well. Figure 2.1-1 presents the locations of the wells and recharge lines.

TABLE 2.1-1. RECOMMENDED COLLECTION WELL PUMPING LEVELS AND OBSERVED RATES.

WELL NO.	RECOMMENDED PUMPING WATER LEVEL (FT-MP)	PUMP INTAKE LEVEL (FT-MP)	AVERAGE YEARLY DISCHARGE (GPM) 2001
5A-1	15.0	19.0	3.41
P1	30.0	36.7	1.16
P3	26.0	26.5	6.03
P4	--	--	2.10
P6	26.0	29.0	2.43
P7	15.5	27.0	1.95
P8A	25.0	28.7	7.65
P9	40.0	47.5	0.43
P10	36.5	37.1	0.64
P11	35.0	35.6	0.38
P12	32.0	--	0.48
P14	34.0	--	1.06
P15	38.0	--	0.26
P16	37.0	--	0.31
P17	33.0	--	0.63
P18	34.0	--	0.53
P19A	--	--	1.99
P20	32.0	--	1.46
P21	29.0	--	4.47
TOTAL GPM			37.4

Note: FT = feet
MP = measuring point
GPM = gallons per minute

The pumpback collection system has averaged about 37 gpm during the year. This is a slight decrease from the 2000 yield. Additional tailings area Surficial aquifer collection averaged approximately 7.9 gpm in 2001.

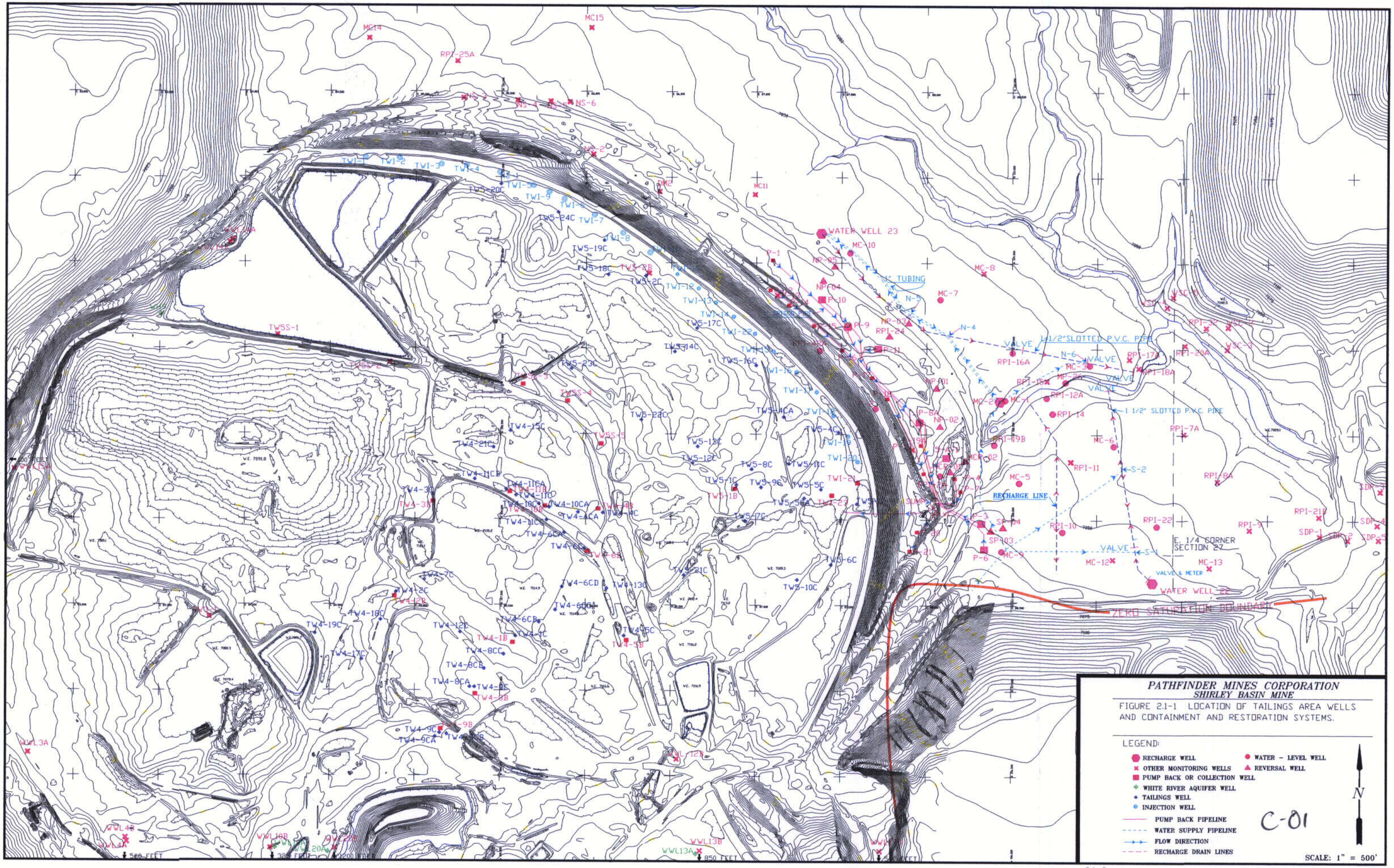
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FIGURE 2.1-1 LOCATION OF TAILINGS AREA WELLS AND CONTAINMENT AND RESTORATION SYSTEMS.
LEGEND:
RECHARGE WELL
WATER - LEVEL WELL
OTHER MONITORING WELLS
REVERSAL WELL
PUMP BACK OR COLLECTION WELL
WHITE RIVER AQUIFER WELL
TAILINGS WELL
INJECTION WELL
PUMP BACK PIPELINE
WATER SUPPLY PIPELINE
FLOW DIRECTION
RECHARGE DRAIN LINES
C-01
N
SCALE: 1" = 500'
WATER WELL 23
WATER WELL 22
ZERO SATURATION BOUNDARY
RECHARGE LINE
1 1/2" SLOTTED P.V.C. PIPE
1" TUBING
VALVE
VALVE & METER
E. 1/4 CORNER SECTION 27

2.2 RECHARGE WELL PUMPING

Pathfinder Mines has injected White River water and Wind River water into the Surficial aquifer to aid the collection system and create a hydraulic barrier. White River wells WW23 and Wind River well WW20 are used to supply this injection water. Table 2.2-1 presents the recommended pumping levels for these recharge wells and some observed pumping rates to the recharge system for 2001. Pumping from recharge well WW22 was discontinued very early in 1999 because water was reaching the surface above the recharge lines.

TABLE 2.2-1. RECOMMENDED RECHARGE SUPPLY WELL PUMPING LEVELS AND OBSERVED RATES.

WELL NO.	RECOMMENDED MAX. WATER LEVEL (FT-MP)	PUMP INTAKE LEVEL (FT-MP)	OBSERVED DISCHARGE (GPM) JANUARY - DECEMBER 2001
WW22	PUMPING DISCONTINUED EARLY IN 1999		
WW23	183	185	13.6
WW20	150	158	97.5
TOTAL GPM			111.1

NOTE: FT = feet
MP = measuring point
GPM = gallons per minute

3.0 TAILINGS AREA AQUIFERS

Table 3.0-1 presents well data for Surficial aquifer wells, Table 3.0-2 presents well data for tailings wells and Table 3.0-3 presents well data for White River aquifer wells in the tailings area. Table 3.0-4 presents well data for Wind River aquifer well WW20.

TABLE 3.0-1. BASIC WELL DATA FOR THE SURFICIAL AQUIFER WELLS.

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
5A-1	108363	88117	21.7	5.0	2.1	7045.81	18-19	3-5
DM-2	109920	86340	46.0	2.0	3.1	7063.00	3-46	0-3
MC01	108702	88470	37.0	6.0	2.2	7043.80	0-37	0-11
MC03	108913	88962	41.5	6.0	3.5	7042.90	0-19	13-15
MC05	108216	88551	47.0	6.0	1.2	7053.10	37-48	25-26
MC06	108437	89107	44.0	6.0	1.7	7046.01	0-38	-
MC07	109296	88091	39.6	6.0	1.1	7049.61	0-40	-
MC08	109444	88336	28.7	6.0	1.1	7045.74	0-25	-
MC09	107818	88447	33.9	6.0	1.9	7056.81	10-37	0-4
MC10	109566	87557	35.5	6.0	1.5	7052.60	0-30	-
MC11	109895	87002	56.5	5.0	1.7	7056.51	0-48	-
MC12	107771	89094	38.0	5.0	1.8	7053.30	0-38	-
MC13	107728	89656	37.6	5.0	2.8	7047.40	0-37	-
MC14	110805	84735	60.1	5.0	2.5	7084.71	0-57	-
MC15	110868	86036	61.7	5.0	1.4	7060.51	0-68	-
MCR01	108275	88145	30.6	2.0	1.5	7042.55	26-29	23-24
MCR02	108349	88239	44.1	2.0	1.6	7046.16	39-42	37-38
MP-26	108783	89129	---	2.0	---	7033.59	-	-
NP01	108770	88056	26.9	2.0	2.1	7051.81	22-24	18-20
NP02	108540	88078	29.7	2.0	1.1	7052.88	21-27	22-23
NP03	109145	87894	23.0	2.0	1.0	7051.07	19-21	16-17
NP04	109392	87392	39.1	2.0	2.3	7055.87	24-27	19-21
NP05	109475	87460	28.9	2.0	2.4	7055.37	21-25	18-21
NS-1	110023	85504	98.1	5.0	1.7	7107.60	76-96	30-58
NS-2	110128	86051	48.8	5.0	1.4	7067.00	8-47	0-5
NS-3	110459	85290	81.0	4.0	1.7	7080.90	39-79	0-53
NS-4	110445	85606	41.9	2.0	1.7	7070.30	20-40	0-10
NS-5	110440	85801	52.5	4.0	1.4	7066.60	11-51	0-10
NS-6	110436	85912	41.9	2.0	2.0	7065.20	20-40	0-25
P-1	109319	87107	37.1	5.0	1.6	7058.12	25-27	21-22
P-10	109289	87383	39.5	5.0	1.3	7055.30	36-37	28-29
P-11	108997	87715	38.5	5.0	0.8	7052.40	33-36	22-23
P-12	109340	87084	36.4	5.0	1.5	7060.69	16-36	0-11
P-13	109311	87125	41.1	2.0	1.2	7059.41	20-40	0-10
P-14	109254	87192	37.6	5.0	1.3	7059.07	16-36	0-11
P-15	109134	87340	41.0	5.0	1.4	7056.96	21-41	0-10
P-16	108991	87503	39.9	5.0	1.7	7055.87	18-38	0-9
P-17	108830	87679	36.3	5.0	1.2	7057.25	25-35	0-10
P-18	108707	87772	37.2	4.0	1.4	7056.77	16-36	0-10
P-19	108408	87919	25.3	4.0	1.1	7055.66	14-34	0-5
P-19A	---	---	---	---	---	---	-	-
P-2	108657	87704	40.9	5.0	1.3	7054.10	38-39	34-35
P-20	107927	87947	34.5	5.0	1.8	7053.14	12-32	0-10
P-21	107817	87904	32.3	5.0	2.2	7056.14	10-30	0-8
P-3	107975	88315	29.6	5.0	1.7	7056.30	25-27	14-15
P-4	108239	88172	---	---	---	---	-	-

TABLE 3.0-1. BASIC WELL DATA FOR THE SURFICIAL AQUIFER WELLS. (cont'd.)

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
P-6	107846	88346	29.9	5.0	1.8	7058.20	28-30	19-21
P-7	108169	88203	32.2	5.0	1.2	7047.10	28-30	24-26
P-8A	108571	87957	30.3	5.0	1.0	7051.40	27-29	22-24
P-9	109127	87537	48.7	5.0	0.9	7053.90	46-48	41-42
RPI-10	107396	88813	25.4	1.3	0.7	7049.41	23-26	14-15
RPI-11	108339	88850	32.4	1.3	1.2	7049.70	29-31	22-24
RPI-14	108625	88752	11.8	1.3	0.4	7041.90	9-11	6-7
RPI-15	108812	88708	20.0	1.3	1.3	7039.60	18-20	15-17
RPI-15A	108000	88700	8.0	1.3	1.1	7040.10	6-8	3-4
RPI-16A	109000	88514	21.0	1.3	1.1	7047.60	31-33	28-29
RPI-17A	108960	89190	13.5	1.3	1.4	7037.00	10-12	9-10
RPI-18A	108895	89253	10.7	1.3	1.2	7031.85	8-10	5-6
RPI-19B	108455	88402	15.3	1.3	1.7	7046.81	11-14	8-10
RPI-20A	109030	89512	7.8	1.3	1.0	7031.61	5-7	2-3
RPI-21B	108018	90329	16.1	1.3	1.3	7036.64	11-14	9-10
RPI-22	107962	89356	20.4	1.3	1.1	7047.48	19-21	14-15
RPI-24	109073	87790	30.4	1.3	1.9	7052.15	28-30	25-26
RPI-24A	109070	87790	20.0	1.3	1.9	7052.30	18-20	15-16
RPI-32	109125	89635	20.0	1.3	---	7036.64	18-20	16-17
RPI-42A	108997	87390	14.3	1.3	1.5	7061.17	14-16	15-16
RPI-44A	109530	87095	18.0	1.3	---	7059.15	16-18	13-14
RPI-5A	108105	87882	15.0	1.3	---	7051.10	11-14	6-8
RPI-7A	108509	89500	21.8	1.3	1.5	7042.90	19-21	13-15
RPI-8	108230	89709	21.0	1.3	---	7039.40	17-20	12-18
RPI-8A	108225	89700	14.4	1.3	1.2	7039.40	11-13	9-10
RPI-9	107947	89891	21.3	1.3	1.1	7041.10	18-21	15-17
SDP-1	107911	90307	---	1.3	---	7038.40	-	-
SDP-2	107891	90470	---	1.3	---	7044.15	-	-
SDP-3	108175	90661	24.1	1.3	2.8	7038.80	-	-
SDP-4	107976	90644	24.1	1.3	3.1	7046.04	-	-
SDP-5	107890	90652	22.8	1.3	3.2	7046.75	-	-
SP03	107932	88383	33.7	2.0	1.3	7056.09	30-31	27-28
SP04	107953	88452	34.4	2.0	1.7	7054.72	31-32	27-28
TW3-1	107430	82380	76.8	5.0	1.8	7096.00	35-75	6-24
TW4-10B	108077	85760	74.9	5.0	1.7	7112.41	53-73	38-58
TW4-11B	108162	85557	78.7	5.0	1.4	7112.26	57-77	30-49
TW4-1B	107287	85575	62.3	5.0	1.0	7114.58	40-60	39-45
TW4-2B	107547	84878	94.1	5.0	0.8	7110.03	72-92	42-62
TW4-3B	108104	85108	91.6	5.0	1.6	7112.47	69-89	49-65
TW4-4B	108062	86075	67.2	5.0	1.8	7112.44	46-66	27-39
TW4-5B	107293	86238	60.8	5.0	1.1	7115.66	39-59	31-42
TW4-6B	107813	86009	75.9	5.0	1.8	7114.32	54-74	34-60
TW4-8B	106979	85355	61.5	5.0	1.5	7117.89	50-60	14-47
TW4-9B	106776	85152	78.4	5.0	1.2	7115.06	57-77	30-50
TW5-1B	108180	86876	90.8	5.0	1.4	7105.56	70-90	54.5-65
TW5-2B	109441	86369	73.5	5.0	0.6	7103.61	52-72	38-53

TABLE 3.0-1. BASIC WELL DATA FOR THE SURFICIAL AQUIFER WELLS. (cont'd.)

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
TW5S-1	109064	84203	94.5	5.0	1.7	7111.70	53-93	11-42
TW5S-2	108917	84849	100.0	5.0	1.0	7112.20	59-99	12-49
TW5S-3	109108	83745	94.0	5.0	1.2	7112.76	53-93	18-37
TW5S-4	109065	84203	100.9	5.0	1.7	7111.69	59-99	20-49
TW5S-5	108916	84849	84.7	5.0	1.0	7107.79	44-84	15-43
TWI-1	110109	84716	96.5	5.0	1.2	7106.50	55-95	23-53
TWI-10	109429	86546	70.4	5.0	1.7	7106.60	39-69	13-49
TWI-11	109554	86386	99.8	5.0	2.0	7106.60	58-98	19-57
TWI-12	109349	86662	83.6	5.0	1.0	7106.26	53-83	0-10
TWI-13	109267	86763	88.7	5.0	0.8	7107.62	68-88	0-22
TWI-14	109186	86867	86.2	5.0	1.8	7108.08	55-85	0-51
TWI-15	108982	87103	75.1	5.0	1.2	7107.51	54-74	0-52
TWI-16	108862	87237	89.3	5.0	1.4	7107.58	58-88	0-18
TWI-17	108746	87355	80.6	5.0	1.0	7107.12	60-80	28-57
TWI-18	108608	87457	87.0	5.0	1.3	7107.79	66-86	0-56
TWI-19	108488	87540	81.7	5.0	1.0	7107.47	61-81	24-55
TWI-2	110106	84916	87.0	5.0	1.7	7106.70	55-85	0-44
TWI-20	108338	87597	86.5	5.0	1.2	7107.85	55-85	0-16
TWI-21	108219	87597	80.7	5.0	1.1	7107.51	49-79	0-50
TWI-22	109086	86993	88.1	5.0	1.3	7107.75	57-87	0-18
TWI-23	108142	87445	82.2	5.0	1.2	7107.64	61-81	0-57
TWI-3	110059	85162	104.8	5.0	1.7	7106.60	63-103	8-54
TWI-4	110063	85309	97.5	5.0	1.7	7107.10	56-96	0-55
TWI-5	109947	85701	93.7	5.0	2.0	7107.40	52-92	8.5-47
TWI-6	109866	85882	91.8	5.0	1.7	7106.60	50-90	7-53
TWI-7	109774	86060	91.5	5.0	2.1	7107.50	49-89	8-53
TWI-8	109668	86227	93.1	5.0	1.2	7106.60	62-92	8-55
TWI-9	109908	85792	104.8	5.0	2.3	7107.10	62-102	24-57
WSC-2	109129	89765	24.2	---	2.5	7045.62	12-17	13-17
WSC-3	109000	89760	13.8	---	2.5	7036.73	6.5-11.5	6-12
WSC-4	109246	89409	15.0	---	2.5	7034.82	8-12.5	6-12
WSC-5	109304	89444	15.3	---	3.1	7043.60	2-12	3.5-12
WWL-10B	105744	84168	68.6	5.0	1.4	7125.10	54-74	22-28
WWL-12B	106598	86537	71.1	5.0	1.1	7118.57	54-74	6-13
WWL-13B	105205	86689	57.2	5.0	1.1	7141.20	40-60	7-17
WWL-14A	109620	83937	95.8	4.0	0.8	7113.00	79-99	44-51
WWL-14B	109609	83923	38.0	5.0	1.9	7113.70	18-38	0-12
WWL-15A	108284	82559	120.0	4.0	1.1	7144.40	110-120	99-107
WWL-19B	104375	87698	56.0	4.0	2.5	7138.50	34-54	27-29
WWL-20B	104861	84544	60.2	4.0	1.4	7139.00	39-59	33-35
WWL-3A	106626	50744	99.3	4.0	1.7	7114.20	81-101	60-70
WWL-4A	105555	83331	95.8	4.0	1.8	7129.90	76-96	62-71
WWL-4B	105575	83322	47.7	4.0	0.7	7127.20	30-50	20-27

TABLE 3.0-2. BASIC WELL DATA FOR THE TAILINGS WELLS.

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
TW4-10C	108089	85727	56.8	5.0	1.7	7112.64	15-55	5-11
TW4-10CA	108070	85787	56.4	4.0	1.1	7112.54	15-55	0-9
TW4-11C	108140	85593	57.3	5.0	1.7	7112.71	15-55	7-12
TW4-11CA	108173	85537	60.0	4.0	1.8	7112.53	18-58	2-10
TW4-11CB	108233	85351	20.5	4.0	1.4	7112.10	0-20	0-0
TW4-11CC	107995	85771	34.6	4.0	1.5	7112.64	13-33	0-5
TW4-12C	107338 e	85268 e	35.0	2.0	---	---	-	-
TW4-13C	107596 e	86124 e	32.6	2.0	---	---	-	-
TW4-15C	108516	85559	37.2	5.0	1.9	7110.38	15-35	7-11
TW4-17C	107180 e	84690 e	33.6	5.0	0.9	---	13-33	-
TW4-18C	107410 e	84800 e	44.3	5.0	0.6	---	4-44	-
TW4-19C	107330 e	84415 e	25.8	5.0	0.8	---	6-25	-
TW4-1C	107317	85592	49.8	5.0	0.3	7112.44	8-48	4.5-6
TW4-1C1	107287	85575	26.2	2.0	1.7	7118.02	15-25	11-15
TW4-1C2	107288	85576	41.7	2.0	1.1	7121.33	29-39	25-30
TW4-21C	108420 e	85460 e	80.0	5.0	---	---	20-80	-
TW4-2C	107573	84890	46.0	5.0	1.0	7109.30	4-44	1.5-4
TW4-2C1	107547	84878	19.5	2.0	1.3	7109.55	8-18	0-7
TW4-3C	108142	85105	33.0	5.0	2.0	7112.26	9-49	1.5-5
TW4-3C1	108104	85108	34.7	2.0	1.7	7112.03	22-32	20-22
TW4-3C2	108105	85109	22.3	2.0	1.6	7111.81	10-20	7-9
TW4-4C	108038	86101	33.0	5.0	1.6	7111.82	12-32	4-6
TW4-4CA	108041	85956	57.6	4.0	1.5	7112.25	-	0-9
TW4-5C	107319	86227	42.0	5.0	1.3	7115.37	21-41	0-5
TW4-6C	107828	85993	47.7	5.0	1.4	7113.93	6-46	4-11
TW4-6CA	107921	85875	35.3	4.0	1.1	7113.37	14-34	0-6
TW4-6CB	107398	85728	26.4	4.0	1.6	7110.73	5-25	1-4
TW4-6CC	107469	85824	40.1	4.0	1.0	7108.15	19-39	0-2
TW4-6CD	107604	85863	40.6	4.0	1.4	7107.91	19-39	17-18
TW4-7C	107645	85057	52.0	5.0	1.1	7113.42	11-51	5-9
TW4-8C	107020	85352	50.5	5.0	1.3	7116.62	9-49	1-13
TW4-8CA	107021	85324	45.4	4.0	1.7	7117.84	24-44	0-24
TW4-8CB	107126	85407	48.1	4.0	1.5	7118.12	27-47	0-31
TW4-8CC	107211	85522	40.3	4.0	1.6	7115.64	19-39	0-2
TW4-9C	106750	85147	40.6	5.0	1.6	7115.35	19-39	0-12
TW4-9CA	106728	85121	39.7	4.0	1.1	7115.61	18-38	0-12
TW4-9CB	106744	85190	20.0	2.0	1.3	7117.10	0-20	0-0
TW4-9CC	106776	85152	---	1.3	---	---	-	-
TW5-10C	107649 e	87244 e	19.2	2.0	---	---	-	-
TW5-12C	108330	86630	22.0	2.0	1.8	7101.28	-	-
TW5-13C	108426	86659	23.4	2.0	1.0	7101.54	-	-
TW5-14C	108984	86518	25.3	2.0	4.1	7097.96	-	-
TW5-16C	108901	87001	41.3	5.0	1.5	7104.21	20-40	11-14
TW5-17C	109118	86653	41.7	5.0	1.9	7103.69	20-40	11-15
TW5-18C	109429	86130	42.1	5.0	2.6	7100.55	20-40	9-13
TW5-19C	109629	86106	41.7	5.0	2.0	7105.72	20-40	6-12

TABLE 3.0-2. BASIC WELL DATA FOR THE TAILINGS WELLS. (cont'd.)

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
TW5-1C	108203	86887	58.8	5.0	2.0	7107.58	17-57	1.5-6
TW5-1C1	108180	86876	32.3	2.0	2.8	---	9-29	0-5
TW5-1C2	108200	86940	54.9	2.0	2.6	---	36-52	29-31
TW5-20C	109959	85500	36.0	5.0	1.7	7106.62	14-34	9-13
TW5-21C	107674	86580	54.8	5.0	1.9	7114.04	33-53	16-20
TW5-22C	108583	86326	37.1	5.0	1.8	7104.30	15-35	7-10
TW5-23C	108881	85916	41.4	5.0	1.5	7104.53	20-40	7-11
TW5-24C	109793	85836	40.0	4.0	1.8	7105.53	18-38	16-18
TW5-2C	109423	86350	38.9	5.0	1.6	7104.04	0-38.4	0-2
TW5-2C1	109441	86369	9.2	2.0	2.3	---	0-9.2	-
TW5-3	108091	87593	43.6	5.0	2.0	7108.50	22-42	2-4
TW5-4C	108510	87485	50.4	5.0	1.6	7108.30	9-49	0-8
TW5-4CA	108600	87163	36.0	4.0	1.7	7108.68	13-33	0-0
TW5-5C	108177	87383	52.3	5.0	1.7	7108.20	21-51	0-8
TW5-5CA	108125	87285	35.5	4.0	1.7	7108.20	14-34	0-2
TW5-6C	107736	87442	47.3	5.0	1.8	7108.40	16-46	0-10
TW5-7C	107991	86938	56.5	5.0	2.8	7108.15	14-54	6-12
TW5-8C	108294	86976	44.2	5.0	1.6	7106.17	3-43	4-5
TW5-9C	108189	87031	34.0	4.0	1.3	7106.57	13-33	0-5

e = Estimated

TABLE 3.0-3. BASIC WELL DATA FOR THE WHITE RIVER AQUIFER WELLS.

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
MC02	108693	88431	165.0	6.0	0.0	7045.21	70-160	28-30
WH-9	109197	83514	190.0	5.0	2.7	7119.80	130-190	113-121
WW-22	107600	89330	184.6	6.0	1.0	7051.00	64-184	21-28
WW-23	109674	87393	193.5	5.0	2.1	7054.40	113-194	70-75
WWL-10A	105745	84187	133.6	4.0	0.7	7125.00	114-134	108-112
WWL-16A	102228	85174	187.2	4.0	2.8	7172.08	165-185	139-145
WWL-18A	103861	83301	171.5	4.0	1.3	7163.10	151-171	124-132
WWL-20A	104821	84547	140.3	4.0	0.8	7139.34	122-142	119-128

TABLE 3.0-4. BASIC WELL DATA FOR THE WIND RIVER AQUIFER WELLS

WELL NAME	NORTH. COORD.	EAST. COORD.	TOTAL DEPTH (ft-mp)	CASING DIAMETER (in)	STICKUP (ft)	MP ELEV. (ft-msl)	CASING PERFORATIONS (ft-lsd)	BENTONITE SEAL (ft-lsd)
WW-20	107450	82240	430.0	7.0	0.3	7114.99	410-425	350-360

3.1 RATE AND DIRECTION OF GROUND-WATER MOVEMENT

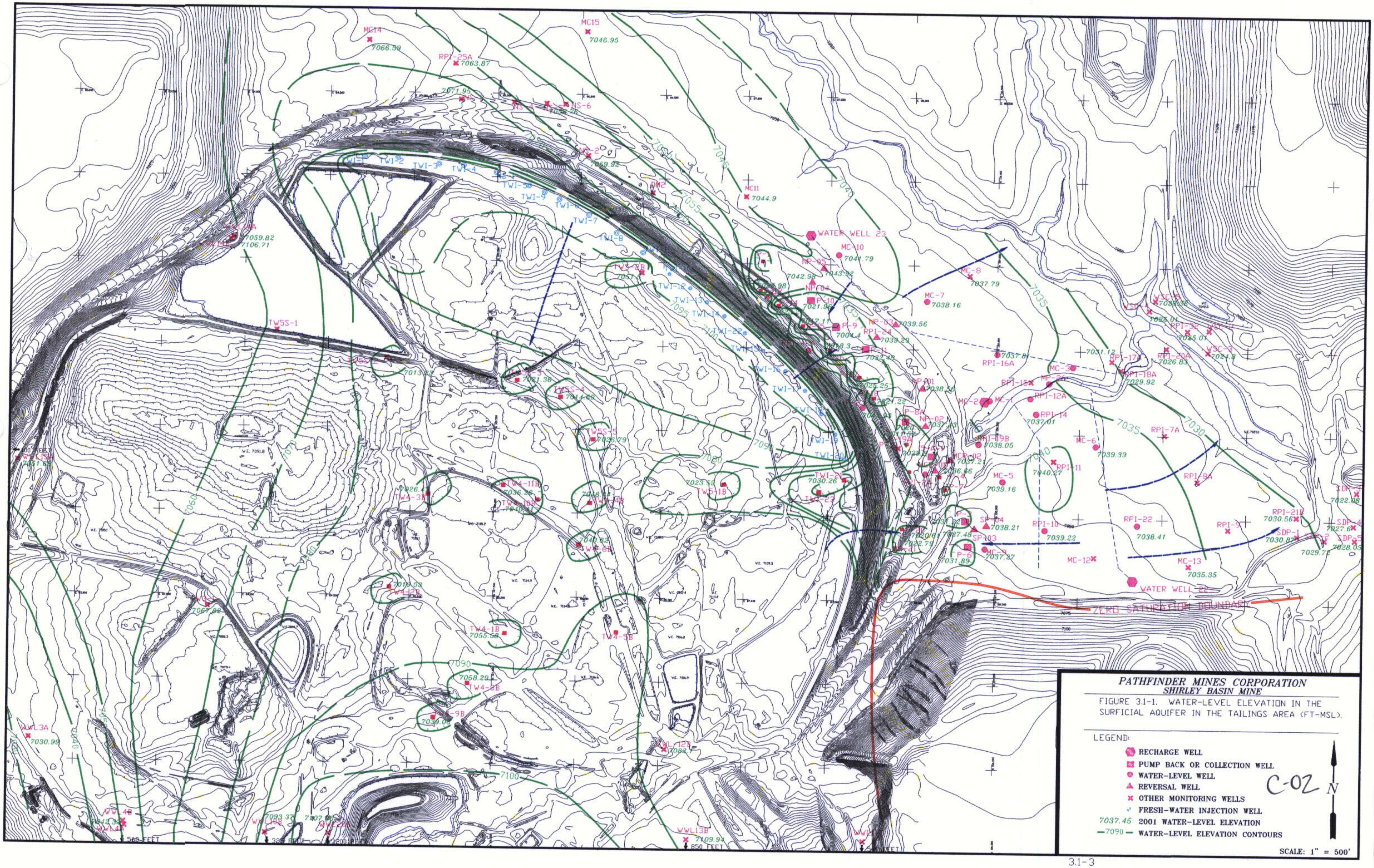
Water-level elevations define the gradient and direction of ground-water flow in the Surficial aquifer. Figure 3.1-1 presents the water-level elevation of the Surficial aquifer in the tailings area. Because the majority of Surficial wells within the actual tailings area have been converted to injection or collection wells, the contours in the immediate vicinity of these wells represent expected water-level elevations outside of the immediate cone of depression or water level mound around each active well.

The general shape of the piezometric surface indicates the complexity of the containment and restoration systems, as well as past artificial and natural recharge. The operation of the collection and recharge system downgradient of the No. 5 Dam will be discussed in more detail in subsequent sections. In the immediate tailings area, the recharge comes from surface runoff, seepage from the industrial pond, recharge to overburden piles south of the tailings area, and seepage from the tailings. To the east, the known outlet is the Mine Creek channel where the primary restoration effort has been directed.

Surficial collection and injection operations within the perimeter of the No. 5 Dam have created a depression in the potentiometric surface in the middle of the tailings, with a hydraulic ridge along the line of injection wells. Continued operation of the collection and injection system should increase the gradient toward the middle of the tailings.

Hydraulic gradient times the horizontal permeability divided by the effective porosity yields the ground-water velocity. The ground water in the south Mine Creek recharge line is presently moving downgradient toward Spring Creek at a rate of 3.75 ft/day based on the present hydraulic gradient and aquifer properties. An average permeability of 25 ft/day, gradient of 0.015 ft/ft and effective porosity of 0.1 were used in this estimate. The gradient on the west side of the south recharge line ranges from approximately 0.003 to 0.013 ft/ft, giving an apparent seepage velocity ranging from 0.75 ft/day to 3.25 ft/day.

The gradient in the north Mine Creek recharge area between wells MC-7 and MC-8 (northeast of the north recharge line) is 0.0012 ft/ft. The piezometric surface between the wells is very flat and appears to steepen dramatically near Spring Creek. Based on water quality measurements, this area has been restored and remains so. The gradient reversal between reversal wells NP04 and NP05 was maintained and there was a substantial restoration of water quality in these wells following operational downtime in 1996 and 1997.


PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE
FIGURE 3.1-1. WATER-LEVEL ELEVATION IN THE SURFICIAL AQUIFER IN THE TAILINGS AREA (FT-MSL).
LEGEND:
RECHARGE WELL
PUMP BACK OR COLLECTION WELL
WATER-LEVEL WELL
REVERSAL WELL
OTHER MONITORING WELLS
FRESH-WATER INJECTION WELL
7037.45 2001 WATER-LEVEL ELEVATION
7090 WATER-LEVEL ELEVATION CONTOURS
SCALE: 1" = 500'
N
C-02
WATER WELL 23
WATER WELL 22
ZERO SATURATION BOUNDARY

3.2 GRADIENT REVERSAL

Pumping of the collection wells is used to establish and maintain gradient reversal in the Surficial aquifer in the Mine Creek area. A gradient reversal exists when the water elevation of monitor wells closest to the recharge line is higher than water elevations of monitor wells closest to the collection wells. This is an important measurement because the lack of reversal for a long period of time lessens the chance of containing tailings seepage. Ten reversal wells are used to evaluate gradient reversal. The following listing is from the north end of the seepage area to the south end. The reversal monitoring wells closest to the recharge lines are: NP05, NP03, NP01, MCR02, and SP04 (see Figure 2.1-1). Paired with these wells are NP04, RPI-24, NP02, MCR01, and SP03, respectively.

Table 3.2-1 presents the monitoring dates and elevations during 2001. Comparison of water-level elevations for these wells indicates continuous reversal in reversal well pairs SP04-SP03, NP01-NP02, NP03-RPI24 and NP05-NP04, (see Figures 3.2-2, 3.2-3, 3.2-4 and 3.2-5 respectively). A brief and minor loss of reversal occurred in well pair MCR02-MCR01 during late spring (see Figure 3.2-1), and the rise in water levels during this period likely indicates additional recharge from precipitation or runoff. The additional recharge aids in restoration and would probably offset any minor detriment associated with the loss of reversal.

TABLE 3.2-1. REVERSAL WELL MONITORING
2001

DATE	01/03/01	02/02/01	03/02/01	04/02/01	05/01/01	06/01/01	07/09/01	08/02/01	09/04/01	10/01/01	11/05/01	12/03/01
WELL												
NPO2	7036.9	FROZEN	7037.04	7038.71	7039.95	7039.45	7038.03	7037.81	7037.44	7037.36	7037.3	7037.13
7052.88	-2.07	-7038.76	-1.73	-0.82	-0.41	-0.9	-1.6	-1.57	-1.6	-1.52	-1.43	-1.47
NPO1	7038.97	7038.76	7038.77	7039.53	7040.36	7040.35	7039.63	7039.38	7039.04	7038.88	7038.73	7038.6
7051.81												
RPI24	7039.21	7039.24	7039.23	7040.37	7040.73	7040.63	7039.98	7039.67	7039.38	7039.2	7038.94	7038.84
7052.15	-0.53	-0.54	-0.61	-0.12	-0.29	-0.29	-0.28	-0.23	-0.28	-0.25	-0.25	-0.25
NPO3	7039.74	7039.78	7039.84	7040.49	7041.02	7040.92	7040.26	7039.9	7039.66	7039.45	7039.19	7039.09
7051.07												
NPO4	7042.66	7042.68	7042.78	7043.58	7044.43	7044.86	7043.9	7043.53	7043.14	7042.94	7042.54	7042.4
7055.87	-0.89	-0.84	-0.77	-1.2	-0.78	-0.49	-0.86	-0.78	-0.87	-0.96	-0.7	-1.12
NPO5	7043.55	7043.52	7043.55	7044.78	7045.21	7045.35	7044.76	7044.31	7044.01	7043.9	7043.24	7043.52
7055.37												
MCRO1	7037.02	7037	7037.04	7039.02	7038.79	7038.7	7037.51	7037.11	7036.84	7036.77	7036.68	7036.63
7042.55	-0.22	-0.31	-0.29	0.1	0	-0.02	-0.33	-0.41	-0.43	-0.44	-0.46	-0.48
MCRO2	7037.24	7037.31	7037.33	7038.92	7038.79	7038.72	7037.84	7037.52	7037.27	7037.21	7037.14	7037.11
7046.16												
SPO3	7037.45	7037.41	7037.42	7037.91	7038.58	7038.85	7038.26	7037.94	7037.56	7037.34	7037.21	7037.16
7056.09	-0.66	-0.9	-0.79	-0.84	-0.62	-0.6	-0.67	-0.69	-0.72	-0.73	-0.93	-0.77
SPO4	7038.11	7038.31	7038.21	7038.75	7039.2	7039.45	7038.93	7038.63	7038.28	7038.07	7038.14	7037.93
7054.72												

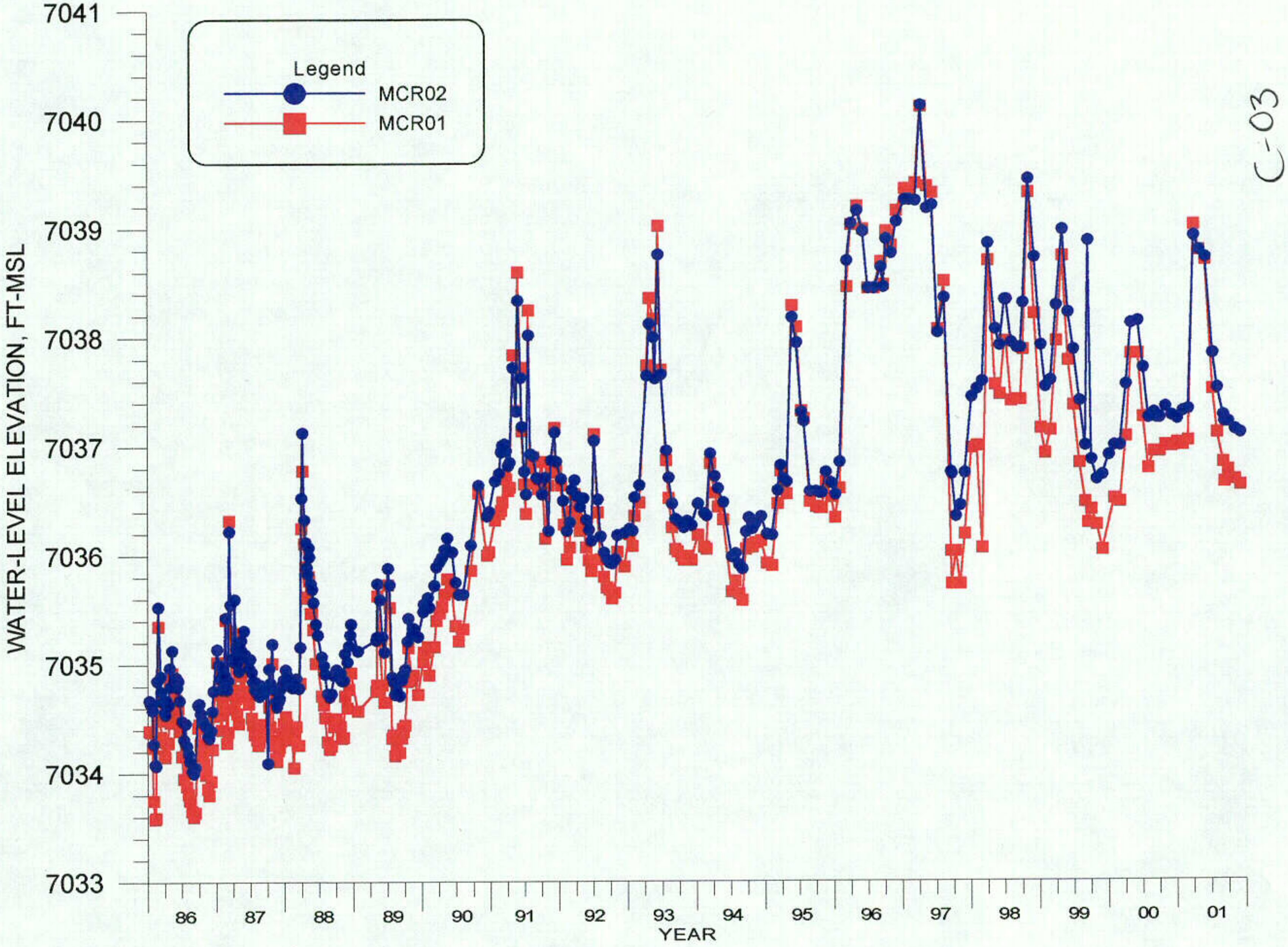


FIGURE 3.2-1. WATER-LEVEL ELEVATION FOR REVERSAL WELLS MCR02 AND MCR01.

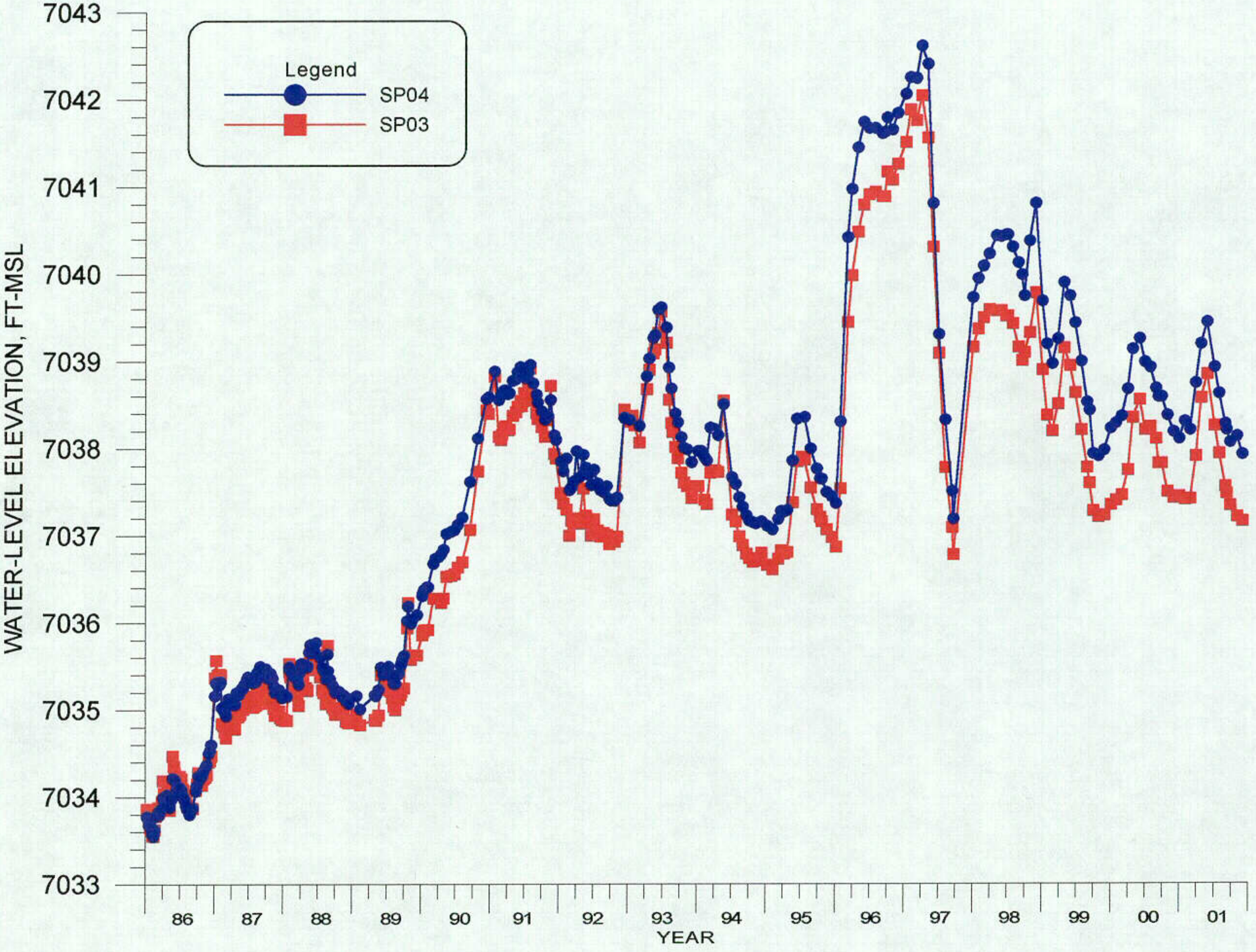


FIGURE 3.2-2. WATER-LEVEL ELEVATION FOR REVERSAL WELLS SP04 AND SP03.

C-04

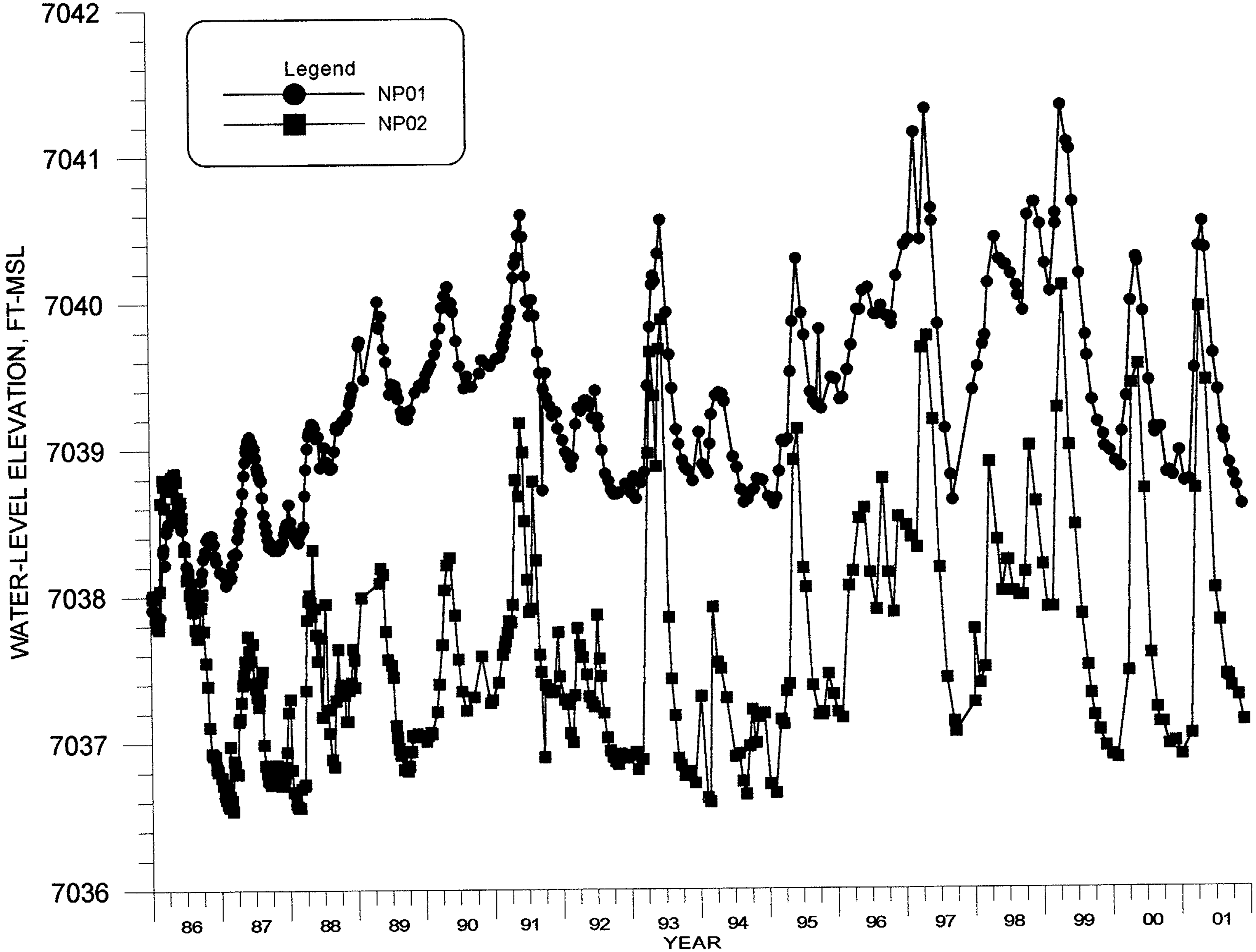


FIGURE 3.2-3. WATER-LEVEL ELEVATION FOR REVERSAL WELLS NP01 AND NP02.

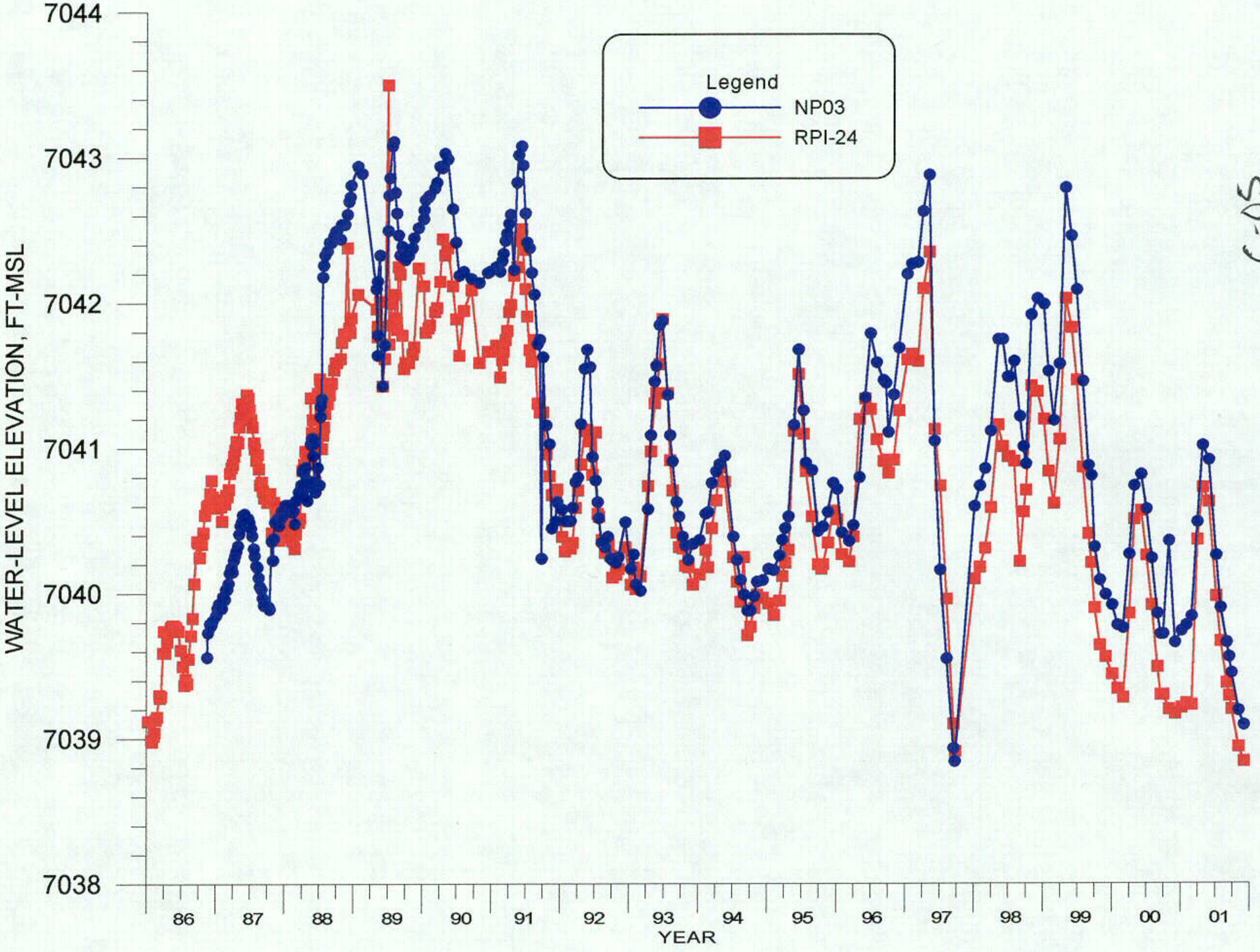


FIGURE 3.2-4. WATER-LEVEL ELEVATION FOR REVERSAL WELLS NP03 AND RPI-24.

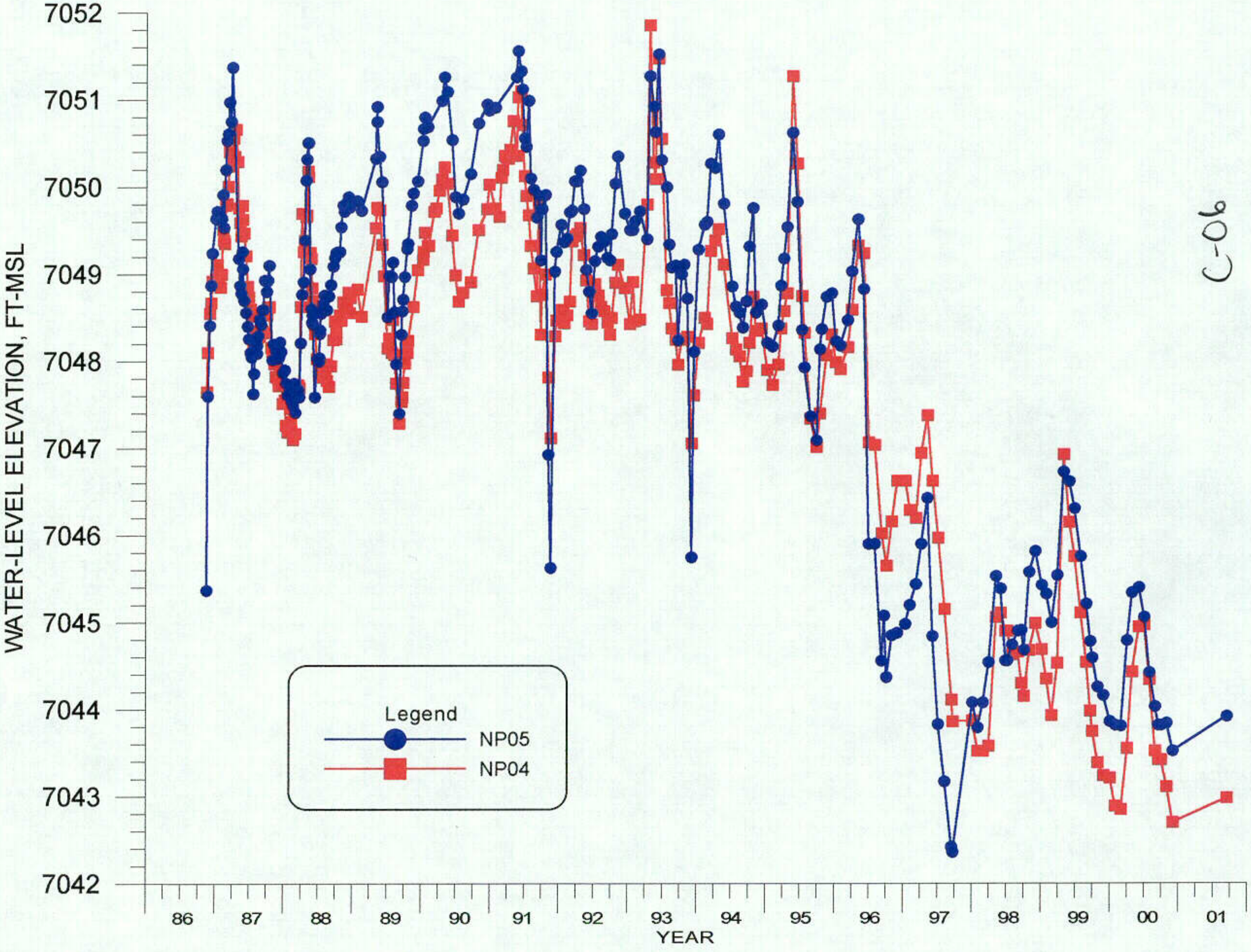


FIGURE 3.2-5. WATER-LEVEL ELEVATION FOR REVERSAL WELLS NP05 AND NP04.

3.3 WATER-LEVEL CHANGES

Water levels are monitored in numerous wells in the Surficial aquifer to define the water level changes from the collection pumping and the injection into the recharge lines and injection wells. Section 3.2 presents the changes in water level in the reversal wells. Water-level changes in several Surficial aquifer wells will be discussed and presented in this section.

Figure 3.3-1 presents the water-level plots for south area Surficial wells RPI-10, RPI-9, and RPI-8A (see Figure 3.1-1 for the locations of these wells with respect to the south drain). Figure 3.3-2 presents the water-level changes in wells MC-6 and RPI-18A, and illustrates that the water-level elevations close to the recharge line have recovered to pseudo-equilibrium with the recharge system operation while wells that are some distance away are unaffected.

The water-level responses between the south recharge line and the Mine Creek collection wells is shown in Figure 3.3-3 for wells RPI-19B, RPI-14, and RPI-20A. Water levels in RPI-20A increased in 1998 but subsequently dropped and have shown a modest increasing trend through 2001. Water levels in wells RPI-19B and RPI-14 have shown a modest decline over the same period. Water levels have responded significantly to recharge into the north Mine Creek recharge line. Magnitude of water-level rises has been a function of the distance from the recharge line in the north area with much greater rises close to the line when it was functioning. Figure 3.3-4 presents the water levels in wells RPI-16A, MC-7, and MC-11. Water-level changes in well MC-7 have been a function of changes in recharge rates into the north line with some seasonal cycling. Well MC-11 has shown a modest decline in water level over the last several years.

There have been no changes in water level in this area that have appreciably changed the ground-water mound over the recharge lines (see Figure 3.1-1). This mound is forcing seepage to the collection system (P wells) on the upgradient side of the recharge lines. This mound has not changed appreciably during 2001.

Water-level changes in the area north of the No. 5 Dam have resulted from the operation of the injection well system. The north injection system consists of 22 injection wells. Figures 3.3-5 and 3.3-6 present the water level elevations for the NS series monitoring wells and well MC-15, which is located farther from the injection wells. The initial rapid water-level change in some wells as a result of injection is evident in Figures 3.3-5 and 3.3-6. All of the downgradient wells have shown a water-level rise as a result of the injection, followed by some decay with the gradual loss of injectivity. Pre-existing trends and seasonal fluctuations also appear to be having some effect on the water-level elevation of more distant wells.

Surficial and tailings collection wells within the tailings impoundment area were made operational during 1994. Surficial wells TW4-1B, TW4-2B, TW4-3B, TW4-4B, TW4-5B, TW4-6B, TW4-8B, TW4-9B, TW4-10B, TW4-11B, TW5-1B, TW5-2B, TWI-21, TWI-23, TW5S-2, TW5S-3, TW5S-4 and TW5S-5 have been pumped. Many of the wells have been pumped nearly continuously for up to six years, while others were installed as late as 1995 and have been pumped intermittently. Well TW4-5B was destroyed in 2000 and well TW5S-1 was abandoned in 2000 because it interfered with the evaporation pond construction. The water level declines for the Surficial Aquifer in the interior of the tailings area range up to 40 feet at the pumping wells, but a practical maximum water level decline outside of the cone of depression for a pumping well is expected to be 20 feet. There is a mild depression in the piezometric surface in the center of the tailings that is formed by the collection in this area and injection along the crest of the No. 5 Dam. The tailings dewatering is discussed in Section 8.0.

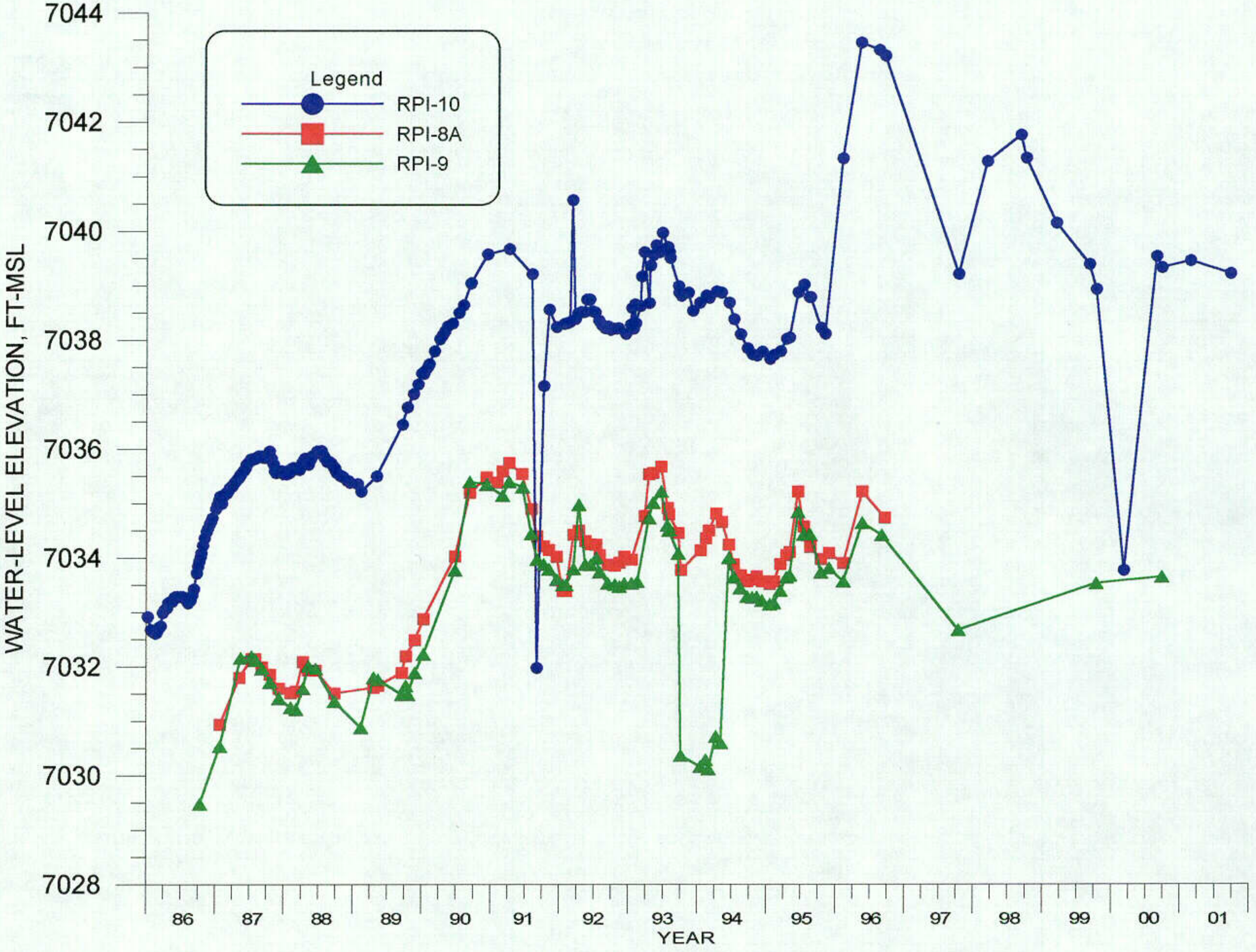


FIGURE 3.3-1. WATER-LEVEL ELEVATION FOR WELLS RPI-10, RPI-8A AND RPI-9.

C-07

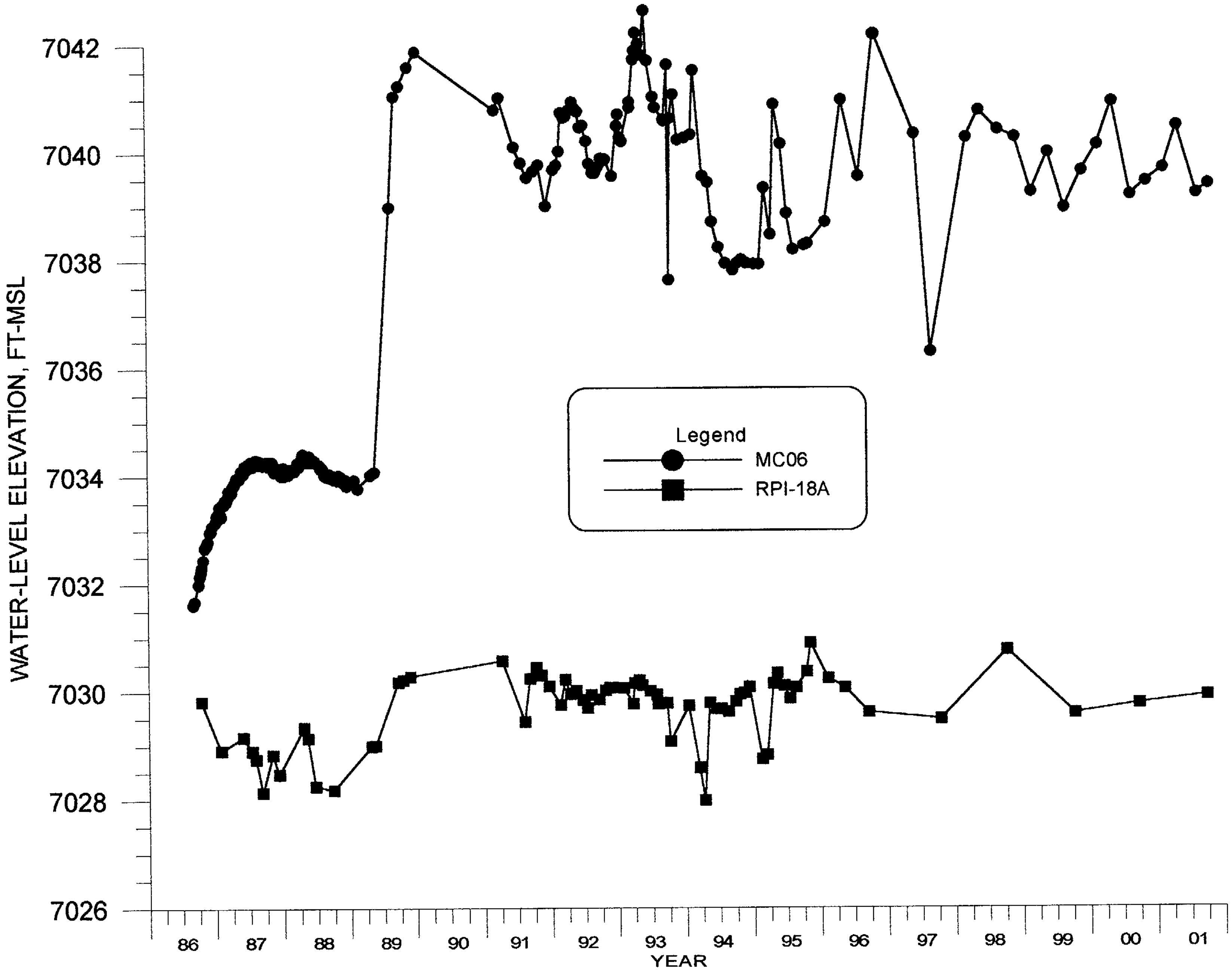


FIGURE 3.3-2. WATER-LEVEL ELEVATION FOR WELLS MC06 AND RPI-18A.

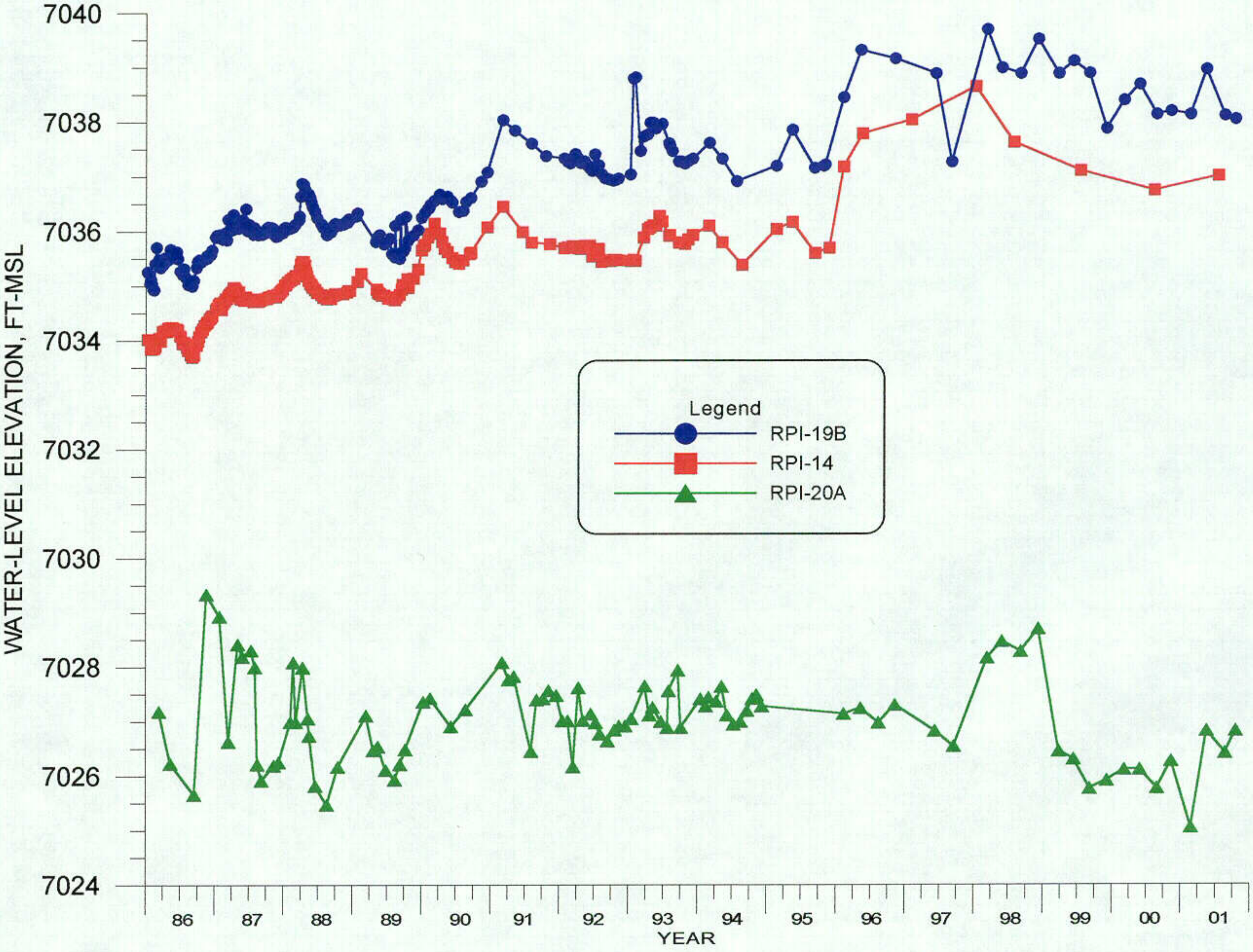
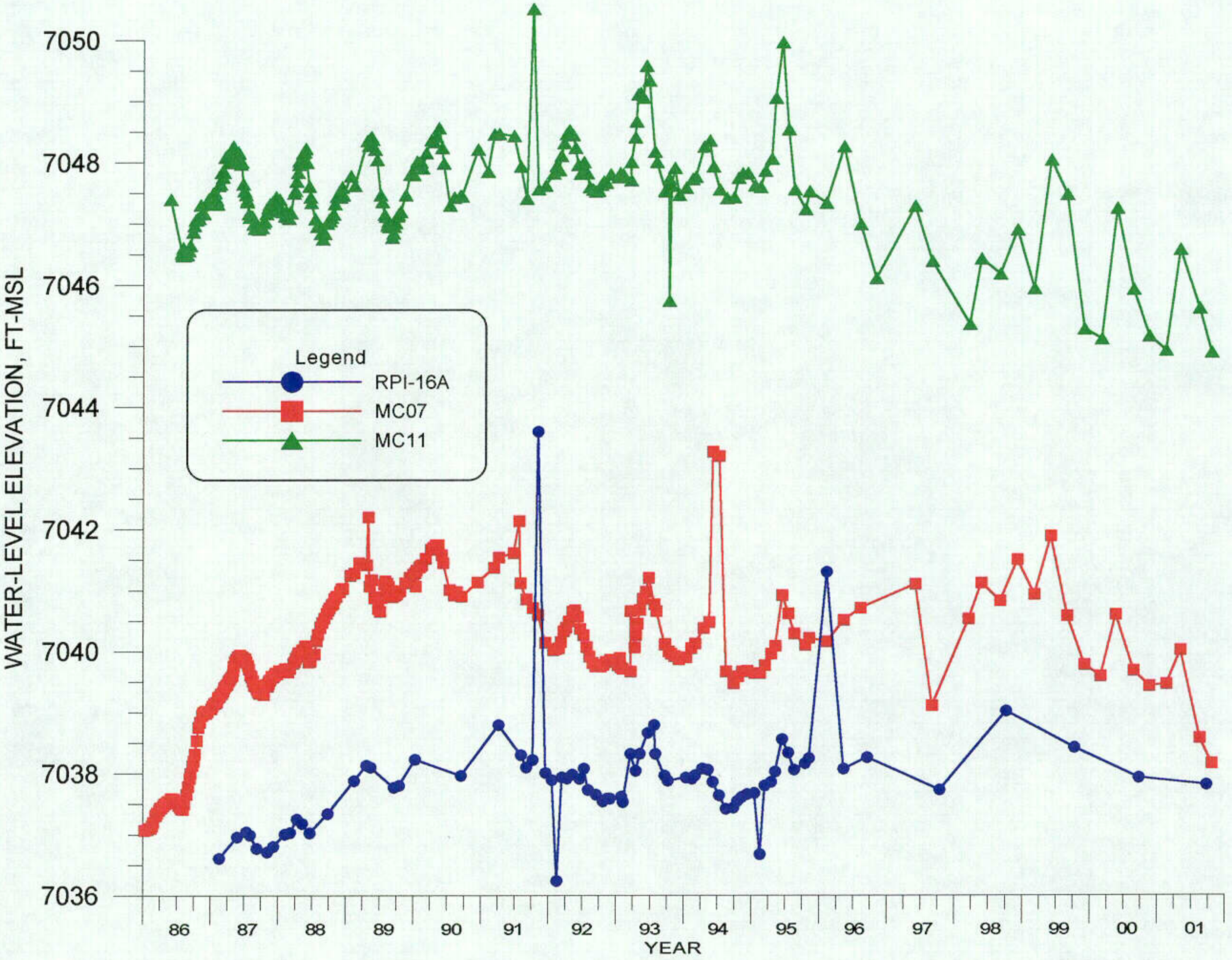


FIGURE 3.3-3. WATER-LEVEL ELEVATION FOR WELLS RPI-19B, RPI-14 AND RPI-20A.

C-08



C-09

3.3-6

FIGURE 3.3-4. WATER-LEVEL ELEVATION FOR WELLS RPI-16A, MC07 AND MC11.

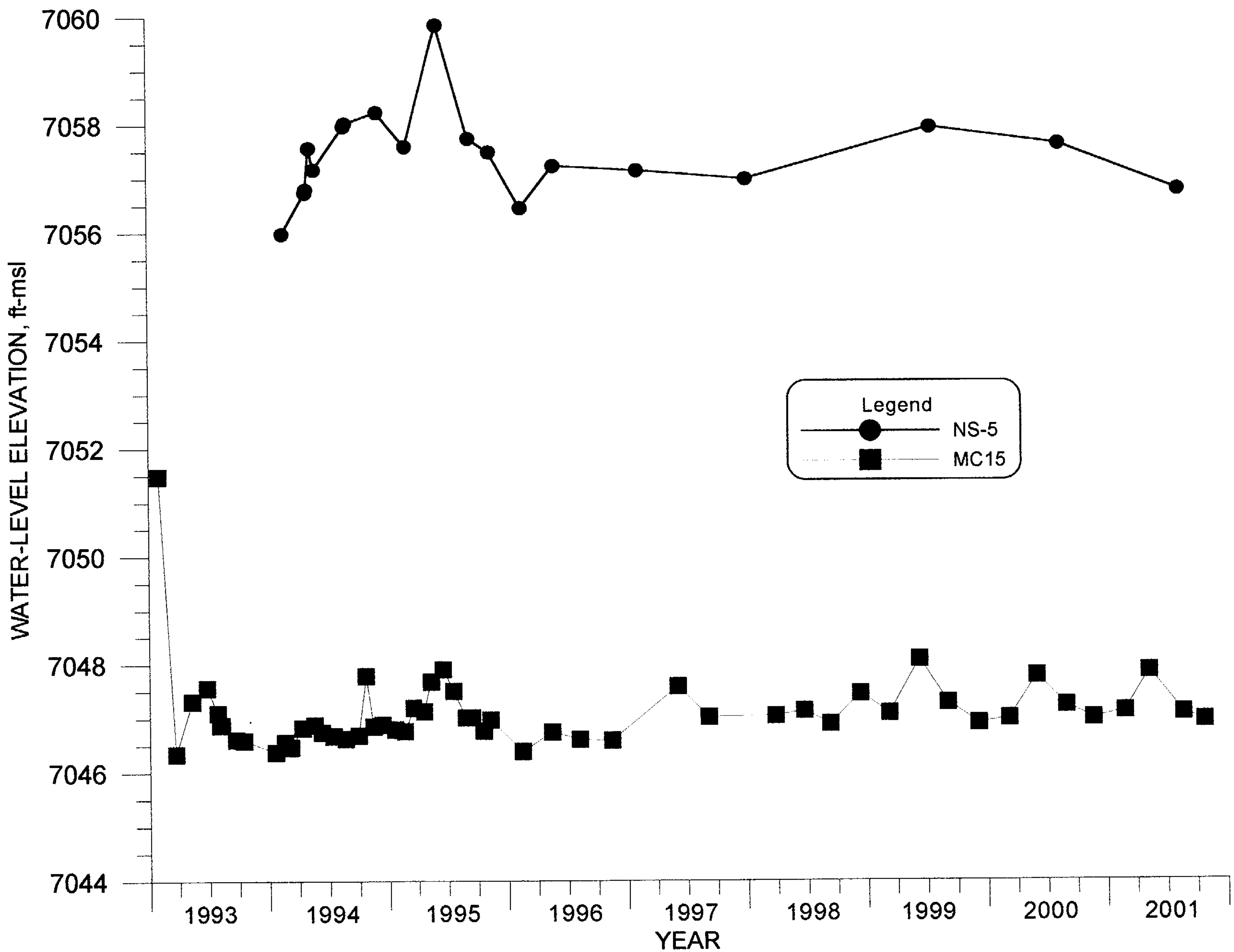


FIGURE 3.3-5. WATER-LEVEL ELEVATION FOR WELLS NS-5 AND MC15.

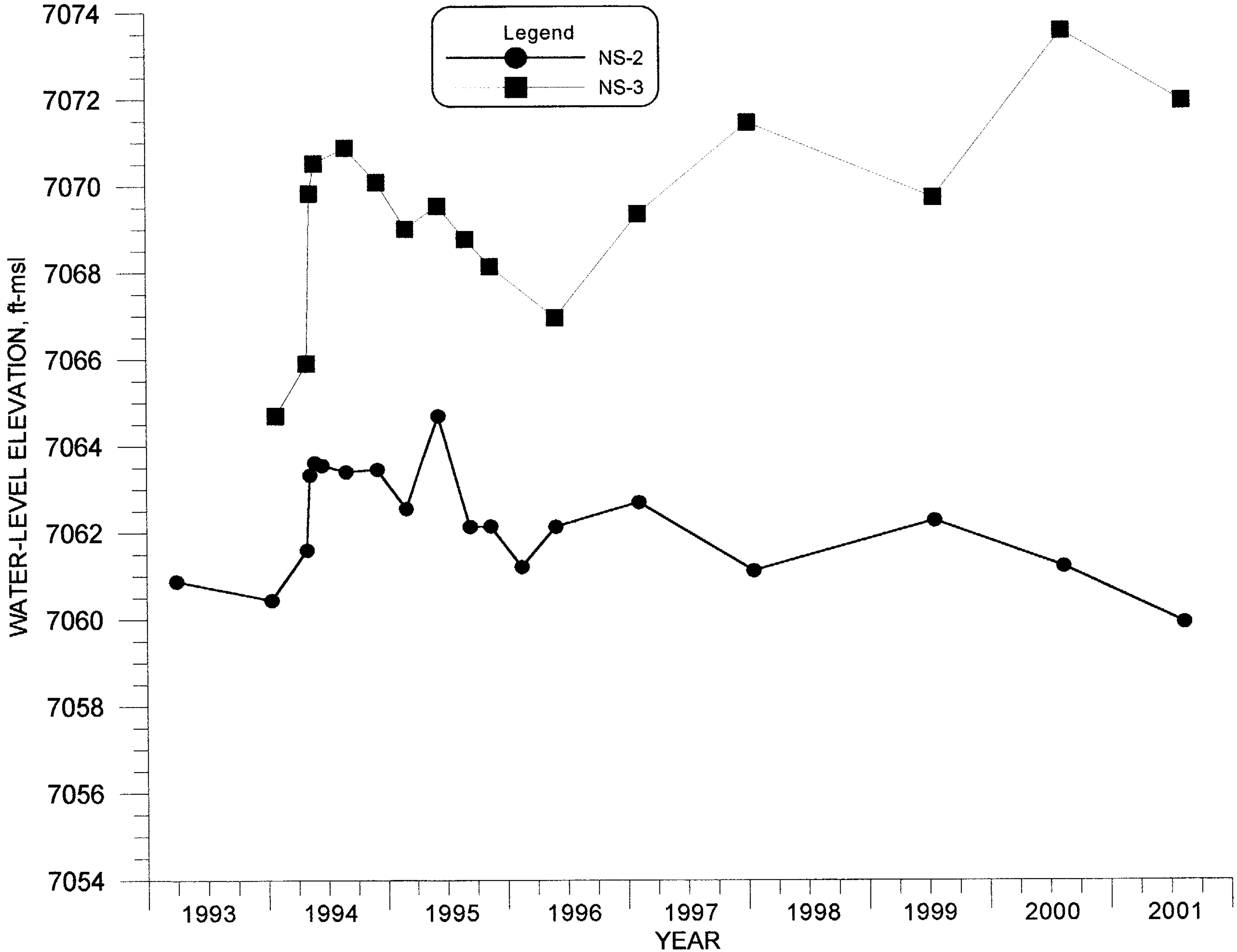


FIGURE 3.3-6. WATER-LEVEL ELEVATION FOR WELLS NS-2 AND NS-3.

4.0 SURFICIAL AQUIFER WATER QUALITY

Tables 4.0-1 and 4.0-2 present year 2001 water quality data for Surficial wells in the tailings area. The year 2001 data is broken into two groups of constituents for the two tables. Values that exceed site standards in Table 1.2-1 are highlighted in Tables 4.0-1 and 4.0-2. Historic water quality data are presented in Appendices A, B and C. Appendix A presents the tabulated water quality data for the Surficial wells. Appendix B presents water quality data for White River wells, Wind River wells and tailings wells in the tailings area. Appendix C presents the surface water quality data. The ordering of the wells in the appendices and in Table 4.0-1 and Table 4.0-2 is done in alphabetical order by well name.

Water quality analyses are used to indicate the direct effect of recharge water on water quality of the Surficial aquifer. The historic indicator parameters are TDS, chloride, and conductivity. A fourth water quality parameter, uranium concentration, is incorporated as the hazardous constituent of interest. For the year 2001, maps displaying measured concentrations or activity of sulfate, radium-226 + radium-228, selenium, and thorium-230 are also included in this report. Of these additional constituents, only sulfate is displayed with iso-concentration contours because it is the only additional constituent that exhibits a discernable site-derived seepage plume. Chloride and TDS concentration will be used in this report to identify and convey the water-quality changes. The field conductivity has been used in the past as an important indicator of water quality. However, conductivity changes for some wells are not supported by the more reliable water quality measures of chloride and TDS concentrations. The chloride and TDS concentrations are considered the primary indicators of water quality. Field conductivity is still considered a gross indication of changes in water quality but is only used when supported by other parameters or when other information is not available.

Figure 4.0-1 presents the chloride contours for the Surficial aquifer in the tailings area for 2001. Chloride ions are usually considered conservative (not affected by chemical reactions or adsorption) in this aquifer and, therefore, a good indicator of ground-water movement rates as well as water quality changes.

Chloride concentrations exceed 1000 mg/l at most of the containment system collection wells. Chloride concentrations are about 50 mg/l or less in the area where the White River and Wind River waters have been recharged into the horizontal drains. The water quality in the Surficial aquifer near the containment system has greatly improved, as well as water quality in areas near Spring Creek. All concentrations downgradient of the recharge line are less than 50 mg/l except wells RPI-11 and RPI-14, where restoration has lagged due to lower permeabilities in this area. TDS and chloride concentrations in wells east of the recharge lines are nearly restored, and have shown little change in recent years. This will be discussed in more detail in subsequent sections.

Figures 4.0-2, 4.0-3, 4.0-4, and 4.0-5 present the TDS, field conductivity, uranium and sulfate contours, respectively, for the Surficial aquifer in the tailings area for 2001. In general, these constituents exhibit similar patterns to chloride. These parameters are more likely to be affected by geochemical or other attenuating processes and typically exhibit more variability in background concentrations than chloride. Hence, there is probably less sensitivity to seepage impacts or corrective action efforts for these constituents when compared to chloride, but the indications of seepage impacts are similar.

Figures 4.0-6 through 4.0-8 present the Ra226 +Ra228, selenium, and thorium-230 activities or concentrations, respectively, for the Surficial aquifer in the tailings area for 2001. Occurrences of elevated concentrations or activities of these constituents do not exhibit discernable seepage patterns.

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY.

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
5A-1	2/14/2001	206	453	6.60	1320	1893	—	—	—	—	—	—
	5/9/2001	405	733	6.50	2100	2870	0.0024	*0.0112*	*1.09*	< 0.200	< 1.000	< 1.20
	8/24/2001	417	814	6.70	2190	2880	—	—	—	—	—	—
	10/22/2001	412	822	6.60	2100	2710	0.0020	0.0100	*0.970*	1.000	< 1.000	< 2.00
MC05	8/14/2001	15.5	279	6.80	646	933	—	—	0.0170	—	—	—
MC06	2/21/2001	11.8	323	5.90	777	1174	—	—	—	—	—	—
	5/9/2001	15.3	432	6.90	1040	1451	0.0465	0.0057	*0.239*	1.40	< 1.000	< 2.40
	8/20/2001	10.9	298	7.50	802	1142	—	—	—	—	—	—
	10/24/2001	9.20	299	7.10	821	1146	0.0500	0.0020	*0.110*	0.600	< 1.000	< 1.60
MC07	2/21/2001	30.6	87.3	6.45	350	590	—	—	—	—	—	—
	5/9/2001	13.5	98.0	7.05	402	600	0.0040	*0.0254*	0.0191	< 0.200	< 1.000	< 1.20
	8/20/2001	14.1	70.0	7.65	365	564	—	—	—	—	—	—
	10/24/2001	13.0	92.1	7.05	397	571	0.0040	*0.0270*	0.0170	< 0.200	1.80	< 2.00
MC08	2/21/2001	18.8	114	6.65	416	689	—	—	—	—	—	—
	9/27/2001	17.9	128	7.40	476	699	0.0120	*0.0250*	0.0200	< 0.200	< 1.000	< 1.20
MC09	2/19/2001	178	334	6.70	1140	1641	—	—	—	—	—	—
	5/9/2001	214	356	6.60	1290	1772	0.0051	*0.0719*	*0.665*	1.30	< 1.000	< 2.30
	8/20/2001	223	361	6.65	1320	1786	—	—	—	—	—	—
	10/24/2001	211	358	6.50	1250	1693	0.0020	*0.0770*	*0.620*	0.500	< 1.000	< 1.50
MC10	8/14/2001	15.2	46.5	7.00	315	504	—	—	0.0270	—	—	—
MC11	2/19/2001	151	33.3	7.05	514	951	—	—	—	—	—	—
	5/9/2001	153	31.4	6.85	582	950	0.0024	0.0019	0.0617	2.00	< 1.000	< 3.00
	8/20/2001	196	60.1	7.25	680	1154	—	—	—	—	—	—

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
MC11	10/24/2001	160	32.0	6.90	546	958	0.0030	0.0020	0.0590	1.60	2.90	4.50
MC13	9/27/2001	10.7	280	7.40	640	903	0.0020	< 0.0010	0.0260	0.500	< 1.000	< 1.50
MC14	2/23/2001	6.30	24.4	7.10	319	547	—	—	—	—	—	—
	5/9/2001	7.00	22.6	7.05	357	551	0.0037	< 0.0010	0.0942	< 0.200	< 1.000	< 1.20
	8/21/2001	9.15	26.7	7.20	354	556	—	—	—	—	—	—
	10/24/2001	7.75	24.5	7.10	346	549	0.0065	0.0053	0.0930	0.400	< 1.000	< 1.40
MC15	2/23/2001	1170	492	6.35	3030	4760	—	—	—	—	—	—
	5/9/2001	1370	556	6.30	3450	5230	—	0.0070	0.457	2.00	—	—
	8/21/2001	1320	592	6.15	3630	5400	—	—	—	—	—	—
	10/24/2001	1310	570	6.10	3600	5200	—	0.0100	0.450	1.30	2.20	3.50
MCR01	9/12/2001	15.1	288	7.00	2100	928	—	0.0021	0.0880	1.000	2.40	3.40
MCR02	9/12/2001	15.5	283	6.90	665	943	—	0.0016	0.110	0.700	< 1.000	< 1.70
NP01	2/26/2001	25.8	114	6.90	441	661	—	—	—	—	—	—
	5/22/2001	24.6	116	7.05	448	663	0.0050	0.0178	0.134	1.10	< 1.000	< 2.20
	8/27/2001	22.2	129	6.90	462	657	—	—	—	—	—	—
	10/22/2001	19.2	103	7.15	424	663	0.0050	0.0220	0.120	0.600	1.50	2.10
NP02	9/17/2001	60.6	220	7.00	671	977	—	0.0270	0.420	0.500	< 1.000	< 1.50
NP03	9/17/2001	13.4	102	7.25	388	584	—	0.0240	0.0200	< 0.200	< 1.000	< 1.20
NP04	9/18/2001	1100	1340	6.30	4550	6070	—	0.0160	1.60	2.20	< 1.000	< 3.20
NP05	9/18/2001	17.6	50.5	7.55	360	518	—	0.0320	0.0390	< 0.200	< 1.000	< 1.20

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
NS-2	8/14/2001	134	114	6.55	627	1047	—	—	0.0510	—	—	—
NS-3	8/14/2001	21.5	160	6.75	520	789	—	—	0.0170	—	—	—
NS-5	8/14/2001	151	27.8	6.75	538	942	—	—	0.0270	—	—	—
P-2	8/14/2001	635	1050	6.30	2850	3710	—	—	*0.470*	—	—	—
P-3	9/18/2001	229	521	6.85	1460	1963	0.0017	0.0100	*0.500*	0.600	< 1.000	< 1.60
P-6	9/19/2001	340	405	6.65	1680	2170	0.0038	*0.0980*	*0.510*	0.700	< 1.000	< 1.70
P-8A	9/19/2001	347	796	7.00	2230	2840	0.0042	*0.0190*	*1.70*	1.000	< 1.000	< 2.00
P-9	9/19/2001	1400	1370	6.70	5140	6360	0.0038	0.0100	*2.30*	1.60	3.00	4.60
P-10	9/19/2001	1290	1140	6.40	4510	5970	0.0035	0.0097	*1.10*	1.20	4.00	*5.20*
P-11	9/19/2001	1480	1640	6.50	5680	7150	0.0051	*0.0130*	*2.50*	2.40	< 1.000	< 3.40
P-12	7/11/2001	1290	1160	6.50	4640	6190	—	—	*1.42*	—	—	—
P-14	7/11/2001	1390	1140	6.45	4710	6500	—	—	*1.59*	—	—	—
P-15	7/11/2001	1450	1460	6.40	5270	6950	—	—	*1.49*	—	—	—
P-16	7/11/2001	1610	1920	6.30	6140	7940	—	—	*1.54*	—	—	—
P-17	7/11/2001	1330	1780	6.30	5560	7040	—	—	*1.47*	—	—	—
P-18	7/13/2001	858	1480	5.60	4130	5090	—	—	*1.69*	—	—	—

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
P-19A	7/13/2001	806	1290	5.90	3580	4630	—	—	2.42	—	—	—
P-20	7/13/2001	1560	1520	5.70	5280	6880	—	—	2.42	—	—	—
P-21	7/13/2001	2660	1810	5.80	7690	10260	—	—	2.00	—	—	—
RPI-10	2/26/2001	18.8	332	7.20	726	940	—	—	—	—	—	—
	9/26/2001	11.3	331	7.20	713	916	0.0020	0.0030	0.320	0.500	< 1.000	< 1.50
RPI-11	7/24/2001	333	230	5.40	1120	1580	—	—	0.281	—	—	—
RPI-14	7/24/2001	144	461	5.70	1140	1595	—	—	0.188	—	—	—
RPI-16A	9/26/2001	21.8	105	7.35	416	602	0.0100	0.0250	0.0260	< 0.200	< 1.000	< 1.20
RPI-17A	9/26/2001	10.6	275	7.45	631	944	0.0020	< 0.0010	0.0190	< 0.200	< 1.000	< 1.20
RPI-18A	9/28/2001	9.70	274	7.25	630	896	0.0040	< 0.0010	0.0390	0.400	< 1.000	< 1.40
RPI-19B	2/26/2001	10.4	282	7.25	618	910	—	—	—	—	—	—
	5/22/2001	11.8	278	6.90	633	871	0.0014	0.0013	0.122	0.600	< 1.000	< 1.60
	8/27/2001	10.2	345	7.00	658	912	—	—	—	—	—	—
	10/23/2001	13.0	273	6.10	634	926	0.0030	0.0010	0.0560	< 0.200	< 1.000	< 1.20
RPI-20A	2/26/2001	20.2	264	7.30	669	1004	—	—	—	—	—	—
	5/22/2001	29.6	276	6.95	722	1039	0.0182	0.0013	0.0153	0.500	< 1.000	< 1.50
	8/27/2001	21.8	324	7.10	730	1033	—	—	—	—	—	—
	10/23/2001	19.9	277	6.40	707	1010	0.0270	0.0010	0.0110	< 0.200	1.80	< 2.00
RPI-21B	2/26/2001	10.4	273	7.20	619	876	—	—	—	—	—	—

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
RPI-21B	5/22/2001	13.4	283	7.00	651	908	0.0027	0.0013	0.107	< 0.200	< 1.000	< 1.20
	8/27/2001	11.6	330	7.25	643	880	—	—	—	—	—	—
	10/23/2001	10.6	289	6.60	639	888	0.0040	0.0010	0.0770	< 0.200	1.50	< 1.70
RPI-22	9/28/2001	10.4	282	7.40	639	938	0.0010	< 0.0010	0.0140	< 0.200	< 1.000	< 1.20
RPI-24	9/18/2001	1070	901	6.65	3710	5030	—	0.0079	1.10	0.700	2.10	2.80
RPI-32	4/25/2001	40.5	93.2	6.90	679	1003	0.0040	< 0.0500	0.340	5.00	< 1.000	< 6.00
	6/27/2001	42.3	91.4	6.90	648	1050	0.0010	0.0020	0.352	2.40	2.90	5.30
SP03	9/12/2001	129	302	6.75	906	1316	—	0.0064	0.280	0.800	1.80	2.60
SP04	9/12/2001	21.5	311	6.95	706	998	—	0.0024	0.170	0.700	< 1.000	< 1.70
TW3-1	8/14/2001	2820	1770	5.80	8520	10840	—	—	1.90	—	—	—
TW4-1B	7/17/2001	2330	4200	5.50	9970	9970	—	—	1.87	—	—	—
TW4-2B	7/17/2001	2660	1450	5.20	8540	11590	—	—	1.39	—	—	—
TW4-3B	7/17/2001	4040	1430	5.60	12000	13590	—	—	2.37	—	—	—
TW4-4B	7/17/2001	2860	3160	5.40	9120	12030	—	—	1.09	—	—	—
TW4-6B	7/17/2001	3910	4460	5.45	13000	16480	—	—	0.251	—	—	—
TW4-8B	7/18/2001	515	2650	5.80	5040	5410	—	—	0.126	—	—	—
TW4-9B	7/18/2001	25.6	2540	3.50	3930	3450	—	—	33.2	—	—	—

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
TW4-10B	7/18/2001	2060	2670	5.40	7760	9950	—	—	2.03	—	—	—
TW4-11B	7/18/2001	2330	2090	5.65	7430	9890	—	—	2.06	—	—	—
TW5-1B	7/18/2001	3570	1420	5.40	8580	12210	—	—	0.909	—	—	—
TW5-2B	7/20/2001	10300	18200	3.25	32300	2950	—	—	4.92	—	—	—
TW5S-2	8/3/2001	618	161	6.60	1550	2420	—	—	0.279	—	—	—
TW5S-3	7/20/2001	798	333	5.30	1600	2330	—	—	0.264	—	—	—
TW5S-4	7/20/2001	1060	694	6.10	3190	4430	—	—	0.710	—	—	—
TW5S-5	7/20/2001	2590	1850	5.80	7790	10020	—	—	1.05	—	—	—
TWI-21	7/13/2001	3550	1820	5.85	9180	12720	—	—	0.538	—	—	—
WSC-3	4/25/2001	24.5	123	7.00	559	799	0.0090	0.0020	0.194	2.90	< 1.000	< 3.90
	6/27/2001	29.5	70.2	7.05	465	747	0.0080	0.0020	0.211	1.60	< 1.000	< 2.60
WSC-4	4/25/2001	31.5	186	7.10	609	874	0.0020	< 0.0500	0.0948	3.00	< 1.000	< 4.00
	6/27/2001	28.3	92.2	7.10	429	708	0.0010	0.0020	0.0845	1.50	< 1.000	< 2.50
WWL-3A	9/24/2001	567	551	6.60	2100	2910	< 0.0010	0.0760	0.270	12.4	6.00	18.4
WWL-4A	9/24/2001	346	529	6.60	1890	2590	< 0.0010	0.0640	0.270	11.0	4.30	15.3
WWL-10B	9/24/2001	96.8	325	7.05	891	1244	< 0.0010	0.0860	0.0780	1.50	2.60	4.10
WWL-12B	9/25/2001	1570	576	6.70	4000	5790	0.0080	0.0270	0.670	3.20	7.90	11.1

TABLE 4.0-1. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd)

Cl THROUGH Ra226+228

Sample Point Name	Date	Cl (mg/l)	SO4 (mg/l)	pH(f) (std. units)	TDS (mg/l)	Cond(f) (µmhos)	As (mg/l)	Se (mg/l)	Unat (mg/l)	Ra226 (pCi/l)	Ra228 (pCi/l)	Ra226+228 (pCi/l)
WWL-13B	9/25/2001	139	931	7.00	2210	2630	0.0090	0.310	11.0	2.30	2.60	4.90
WWL-14A	9/25/2001	328	169	6.60	1140	1724	0.0050	0.0280	0.200	0.800	< 1.000	< 1.80
WWL-14B	9/25/2001	6510	1840	5.60	14100	2070	0.0030	0.0720	2.60	14.5	17.9	32.4
WWL-15A	9/25/2001	1260	420	6.25	2970	4560	< 0.0010	0.0790	0.270	3.30	3.90	7.20
WWL-20B	9/26/2001	56.7	342	6.80	1000	1267	0.0060	0.0170	0.0520	1.40	2.60	4.00

NOTES: [shaded] indicates that value exceeds the NRC site standard.
"<" sign before a value indicates that the value is less than the detection limit.
An "f" subscript on a parameter indicates that values were field measured.
All values are in MG/L unless otherwise noted and the following:
COND = conductivity in micromhos/cm @ 25 DEC. C
pH = pH, in standard units
"#" symbol before a value indicates that the value was a re-check sample.

TABLE 4.0-2. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY.

Th-230 THROUGH Ni

Sample Point Name	Date	Th230 (pCi/l)	Alpha (pCi/l)	Ba (mg/l)	Be (mg/l)	Cd (mg/l)	Cr (mg/l)	NO3 (mg/l)	Fe (mg/l)	Pb (mg/l)	Mo (mg/l)	Ni (mg/l)
5A-1	2/14/2001	—	—	—	—	—	—	0.610	—	—	—	—
	5/9/2001	< 1.000	2.20	< 0.100	< 0.0100	< 0.0050	< 0.0500	2.06	—	< 0.0500	< 0.100	< 0.0500
	8/24/2001	—	—	—	—	—	—	1.24	—	—	—	—
	10/22/2001	< 0.200	1.40	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.700	—	< 0.0500	< 0.100	< 0.0500
MC06	2/21/2001	—	—	—	—	—	—	< 0.100	—	—	—	—
	5/9/2001	< 1.000	2.50	< 0.100	< 0.0100	< 0.0050	< 0.0500	0.110	—	< 0.0500	< 0.100	< 0.0500
	10/24/2001	< 0.200	1.20	< 0.100	< 0.0100	< 0.0100	< 0.0500	< 0.100	—	< 0.0500	< 0.100	< 0.0500
MC07	2/21/2001	—	—	—	—	—	—	0.930	—	—	—	—
	5/9/2001	< 1.000	3.10	< 0.100	< 0.0100	< 0.0050	< 0.0500	1.07	—	< 0.0500	< 0.100	< 0.0500
	8/20/2001	—	—	—	—	—	—	0.840	—	—	—	—
	10/24/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.800	—	< 0.0500	< 0.100	< 0.0500
MC08	2/21/2001	—	—	—	—	—	—	1.34	—	—	—	—
	9/27/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.30	—	< 0.0500	< 0.100	< 0.0500
MC09	2/19/2001	—	—	—	—	—	—	3.74	—	—	—	—
	5/9/2001	< 1.000	3.10	< 0.100	< 0.0100	< 0.0050	< 0.0500	4.31	—	< 0.0500	< 0.100	< 0.0500
	8/20/2001	—	—	—	—	—	—	4.64	—	—	—	—
	10/24/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	4.00	—	< 0.0500	< 0.100	< 0.0500
MC11	2/19/2001	—	—	—	—	—	—	0.140	—	—	—	—
	5/9/2001	< 1.000	3.80	< 0.100	< 0.0100	< 0.0050	< 0.0500	0.240	—	< 0.0500	< 0.100	< 0.0500
	10/24/2001	< 0.200	1.40	< 0.100	< 0.0100	< 0.0100	< 0.0500	< 0.100	—	< 0.0500	< 0.100	< 0.0500
MC13	9/27/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.400	—	< 0.0500	< 0.100	< 0.0500
MC14	2/23/2001	—	—	—	—	—	—	0.190	—	—	—	—
	5/9/2001	< 1.000	< 1.000	< 0.100	< 0.0100	< 0.0050	< 0.0500	0.240	—	< 0.0500	< 0.100	< 0.0500

TABLE 4.0-2. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd.)

Th-230 THROUGH Ni

Sample Point Name	Date	Th230 (pCi/l)	Alpha (pCi/l)	Ba (mg/l)	Be (mg/l)	Cd (mg/l)	Cr (mg/l)	NO3 (mg/l)	Fe (mg/l)	Pb (mg/l)	Mo (mg/l)	Ni (mg/l)
MC14	10/24/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.0600	—	< 0.0500	< 0.100	< 0.0500
MC15	2/23/2001	—	—	—	—	—	—	0.390	—	—	—	—
	5/9/2001	—	3.40	—	—	—	—	4.54	—	—	—	—
	8/21/2001	—	—	—	—	—	—	0.420	—	—	—	—
	10/24/2001	—	1.20	—	—	—	—	0.370	—	—	—	—
MCR01	9/12/2001	—	< 1.000	—	—	—	—	0.170	—	—	—	—
MCR02	9/12/2001	—	< 1.000	—	—	—	—	< 0.100	—	—	—	—
NP01	2/26/2001	—	—	—	—	—	—	0.820	—	—	—	—
	5/22/2001	< 0.200	< 1.000	< 0.100	< 0.100	< 0.0050	< 0.0500	2.90	—	< 0.0500	< 0.100	< 0.0500
	8/27/2001	—	—	—	—	—	—	1.36	—	—	—	—
	10/22/2001	< 0.200	1.20	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.40	—	< 0.0500	< 0.100	< 0.0500
NP02	9/17/2001	—	< 1.000	—	—	—	—	1.07	—	—	—	—
NP03	9/17/2001	—	< 1.000	—	—	—	—	0.760	—	—	—	—
NP04	9/18/2001	—	3.10	—	—	—	—	0.410	—	—	—	—
NP05	9/18/2001	—	< 1.000	—	—	—	—	0.940	—	—	—	—
P-3	9/18/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.18	—	< 0.0500	< 0.100	< 0.0500
P-6	9/19/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	6.25	—	< 0.0500	< 0.100	< 0.0500
P-8A	9/19/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	2.06	—	< 0.0500	< 0.100	< 0.0500
P-9	9/19/2001	< 0.200	2.60	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.840	—	< 0.0500	< 0.100	< 0.0500

TABLE 4.0-2. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd.)

Th-230 THROUGH Ni

Sample Point Name	Date	Th230 (pCi/l)	Alpha (pCi/l)	Ba (mg/l)	Be (mg/l)	Cd (mg/l)	Cr (mg/l)	NO3 (mg/l)	Fe (mg/l)	Pb (mg/l)	Mo (mg/l)	Ni (mg/l)
P-10	9/19/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.310	—	< 0.0500	< 0.100	< 0.0500
P-11	9/19/2001	< 0.200	2.60	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.67	—	< 0.0500	< 0.100	< 0.0500
RPI-10	2/26/2001	—	—	—	—	—	—	0.110	—	—	—	—
	9/26/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.300	—	< 0.0500	< 0.100	< 0.0500
RPI-16A	9/26/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.10	—	< 0.0500	< 0.100	< 0.0500
RPI-17A	9/26/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	< 0.100	—	< 0.0500	< 0.100	< 0.0500
RPI-18A	9/28/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.200	—	< 0.0500	< 0.100	< 0.0500
RPI-19B	2/26/2001	—	—	—	—	—	—	0.390	—	—	—	—
	5/22/2001	< 0.200	< 1.000	< 0.100	< 0.100	< 0.0050	< 0.0500	0.370	—	< 0.0500	< 0.100	< 0.0500
	8/27/2001	—	—	—	—	—	—	0.390	—	—	—	—
	10/23/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.500	—	< 0.0500	< 0.100	< 0.0500
RPI-20A	2/26/2001	—	—	—	—	—	—	< 0.100	—	—	—	—
	5/22/2001	< 0.200	< 1.000	< 0.100	< 0.100	< 0.0050	< 0.0500	< 0.100	—	< 0.0500	< 0.100	< 0.0500
	8/27/2001	—	—	—	—	—	—	< 0.100	—	—	—	—
	10/23/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.100	—	< 0.0500	< 0.100	< 0.0500
RPI-21B	2/26/2001	—	—	—	—	—	—	0.310	—	—	—	—
	5/22/2001	< 0.200	< 1.000	< 0.100	< 0.100	< 0.0050	< 0.0500	0.420	—	< 0.0500	< 0.100	< 0.0500
	8/27/2001	—	—	—	—	—	—	0.180	—	—	—	—
	10/23/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.400	—	< 0.0500	< 0.100	< 0.0500
RPI-22	9/28/2001	0.900	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	0.400	—	< 0.0500	< 0.100	< 0.0500

TABLE 4.0-2. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd.)

Th-230 THROUGH Ni

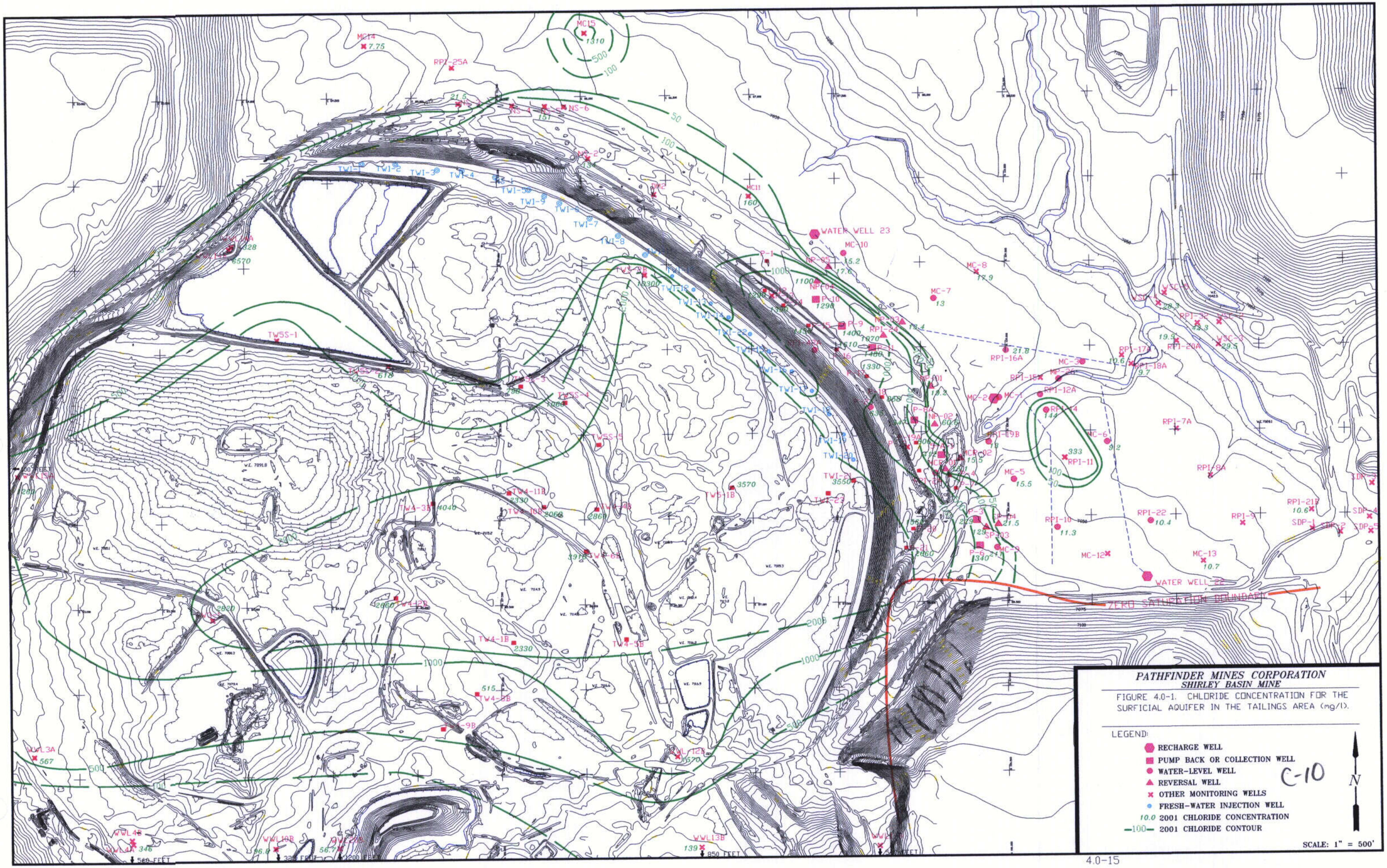
Sample Point Name	Date	Th230 (pCi/l)	Alpha (pCi/l)	Ba (mg/l)	Be (mg/l)	Cd (mg/l)	Cr (mg/l)	NO3 (mg/l)	Fe (mg/l)	Pb (mg/l)	Mo (mg/l)	Ni (mg/l)
RPI-24	9/18/2001	---	< 1.000	---	---	---	---	1.04	---	---	---	---
RPI-32	4/25/2001	< 0.200	4.50	0.200	< 0.100	< 0.0050	< 0.0500	< 0.100	---	---	< 0.0500	< 0.100
	6/27/2001	0.900	3.00	0.200	< 0.100	< 0.0050	< 0.0500	< 0.100	---	< 0.0500	< 0.100	< 0.0500
SP03	9/12/2001	---	< 1.000	---	---	---	---	1.000	---	---	---	---
SP04	9/12/2001	---	< 1.000	---	---	---	---	0.730	---	---	---	---
WSC-3	4/25/2001	< 0.200	4.30	< 0.100	< 0.100	< 0.0050	< 0.0500	1.20	---	---	< 0.100	< 0.0500
	6/27/2001	0.900	2.50	< 0.100	< 0.100	< 0.0050	< 0.0500	0.470	---	< 0.0500	< 0.100	< 0.0500
WSC-4	4/25/2001	< 0.200	4.30	0.100	< 0.100	< 0.0050	< 0.0500	2.51	---	---	< 0.0500	< 0.100
	6/27/2001	9.10	3.10	0.100	< 0.100	< 0.0050	< 0.0500	0.280	---	< 0.0500	< 0.100	< 0.0500
WWL-3A	9/24/2001	< 0.200	13.9	< 0.100	< 0.0100	< 0.0100	< 0.0500	11.0	---	< 0.0500	< 0.100	< 0.0500
WWL-4A	9/24/2001	< 0.200	12.5	< 0.100	< 0.0100	< 0.0100	< 0.0500	9.60	---	< 0.0500	< 0.100	< 0.0500
WWL-10B	9/24/2001	< 0.200	3.40	< 0.100	< 0.0100	< 0.0100	< 0.0500	6.50	---	< 0.0500	< 0.100	< 0.0500
WWL-12B	9/25/2001	< 0.200	5.50	0.100	< 0.0100	< 0.0100	< 0.0500	6.60	---	< 0.0500	< 0.100	< 0.0500
WWL-13B	9/25/2001	< 0.200	3.50	< 0.100	< 0.0100	< 0.0100	< 0.0500	6.80	---	< 0.0500	< 0.100	< 0.0500
WWL-14A	9/25/2001	< 0.200	< 1.000	< 0.100	< 0.0100	< 0.0100	< 0.0500	1.60	---	< 0.0500	< 0.100	< 0.0500
WWL-14B	9/25/2001	< 0.200	19.2	< 0.100	< 0.0100	0.0200	< 0.0500	< 0.100	---	< 0.0500	< 0.100	0.550
WWL-15A	9/25/2001	< 0.200	2.40	< 0.100	< 0.0100	< 0.0100	< 0.0500	3.06	---	< 0.0500	< 0.100	0.0700

TABLE 4.0-2. YEAR 2001 SHIRLEY BASIN MINE SURFICIAL AQUIFER WATER QUALITY. (cont'd.)

Th-230 THROUGH Ni

Sample Point Name	Date	Th230 (pCi/l)	Alpha (pCi/l)	Ba (mg/l)	Be (mg/l)	Cd (mg/l)	Cr (mg/l)	NO3 (mg/l)	Fe (mg/l)	Pb (mg/l)	Mo (mg/l)	Ni (mg/l)
WWL-20B	9/26/2001	< 0.200	1.80	0.200	< 0.0100	< 0.0100	< 0.0500	6.20	---	< 0.0500	< 0.100	< 0.0500

NOTES: [shaded] indicates that value exceeds the NRC site standard.
"<" sign before a value indicates that the value is less than the detection limit.
An "f" subscript on a parameter indicates that values were field measured.
All values are in MG/L unless otherwise noted and the following:
COND = conductivity in micromhos/cm @ 25 DEC. C
pH = pH, in standard units
"#" symbol before a value indicates that the value was a re-check sample.


PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE
FIGURE 4.0-1. CHLORIDE CONCENTRATION FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (mg/l).
LEGEND:
RECHARGE WELL
PUMP BACK OR COLLECTION WELL
WATER-LEVEL WELL
REVERSAL WELL
OTHER MONITORING WELLS
FRESH-WATER INJECTION WELL
10.0 2001 CHLORIDE CONCENTRATION
100 2001 CHLORIDE CONTOUR
SCALE: 1" = 500'
N
C-10
WATER WELL 23
WATER WELL 22
ZERO SATURATION BOUNDARY

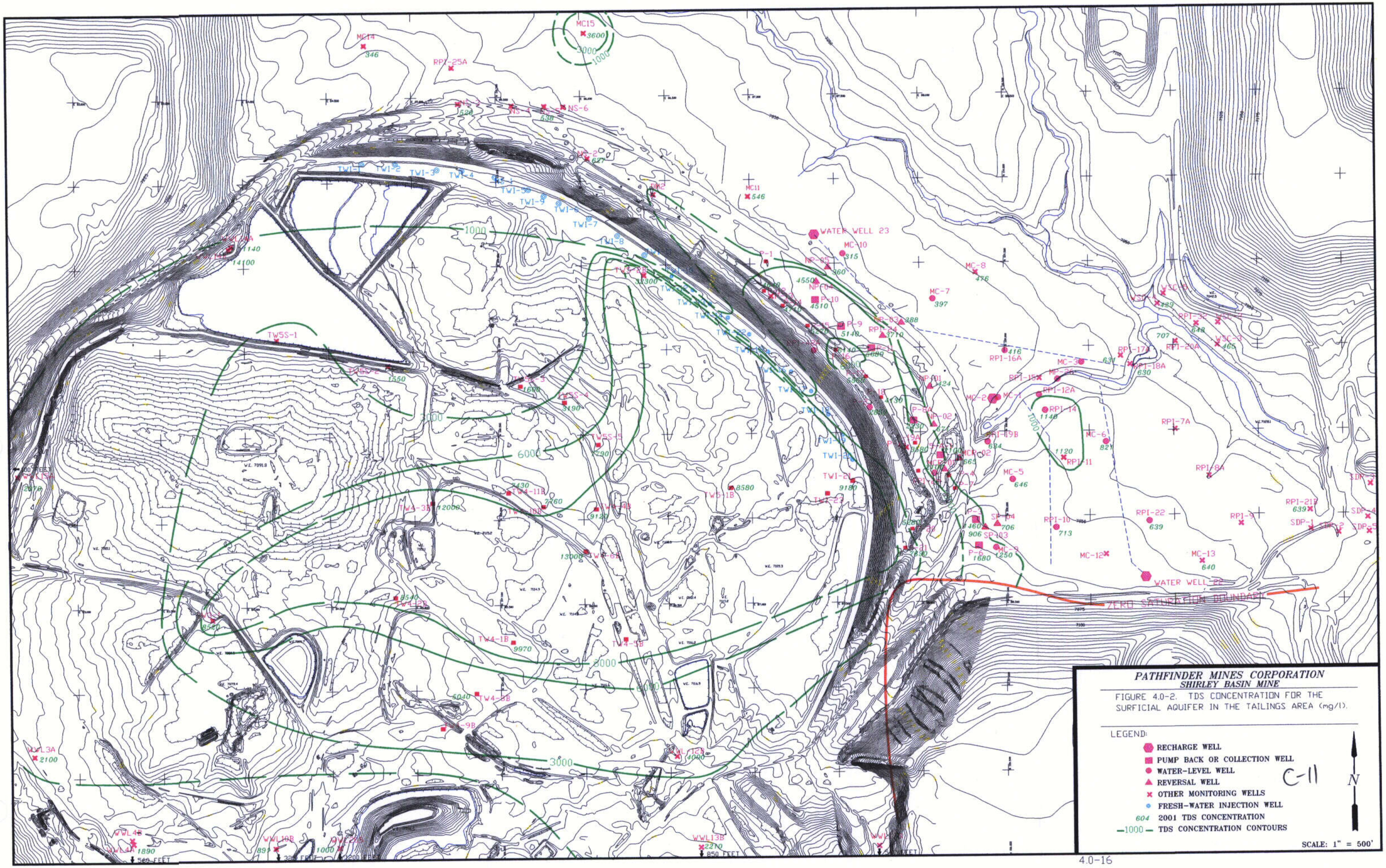


FIGURE 4.0-2. TDS CONCENTRATION FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (mg/l).

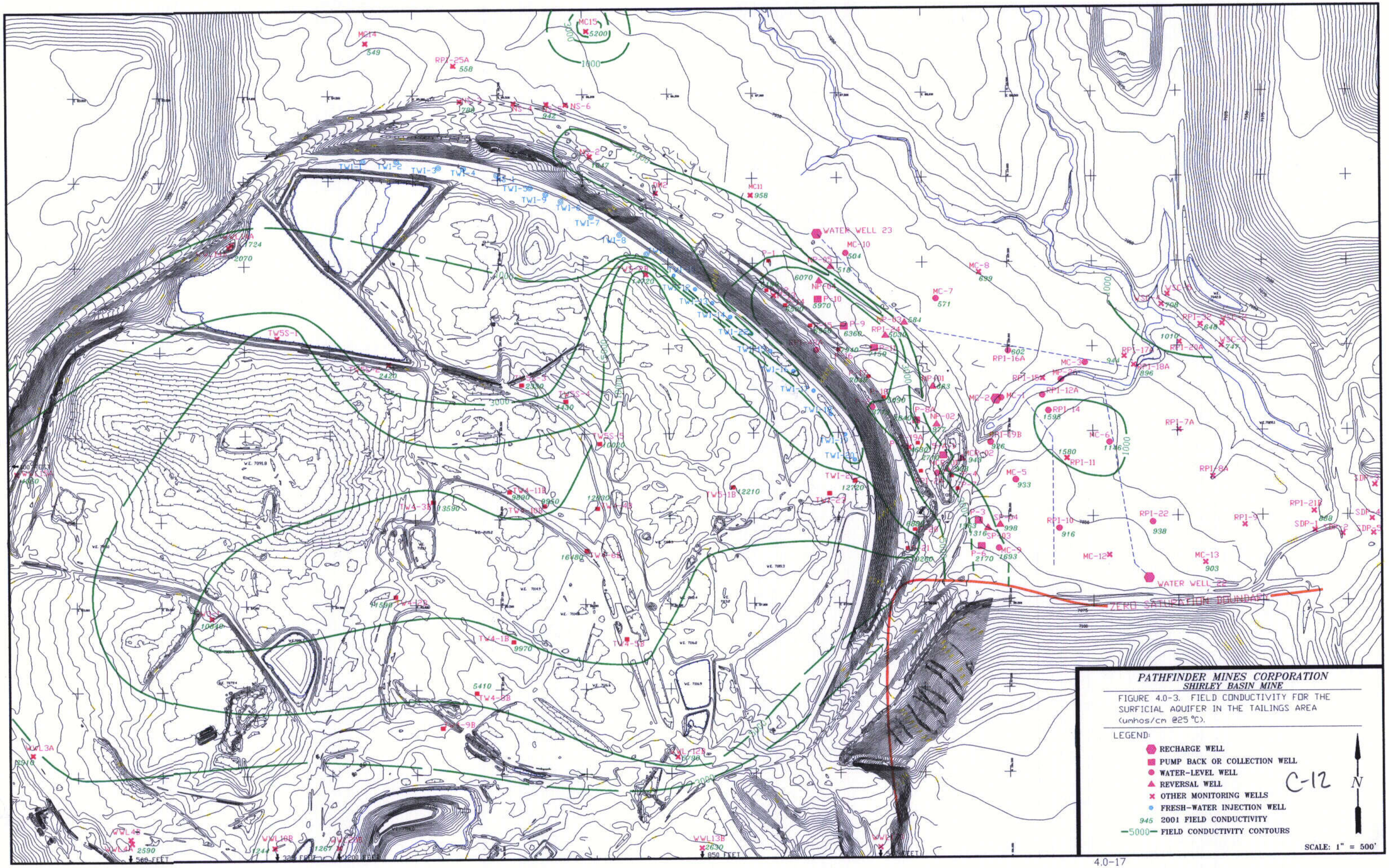
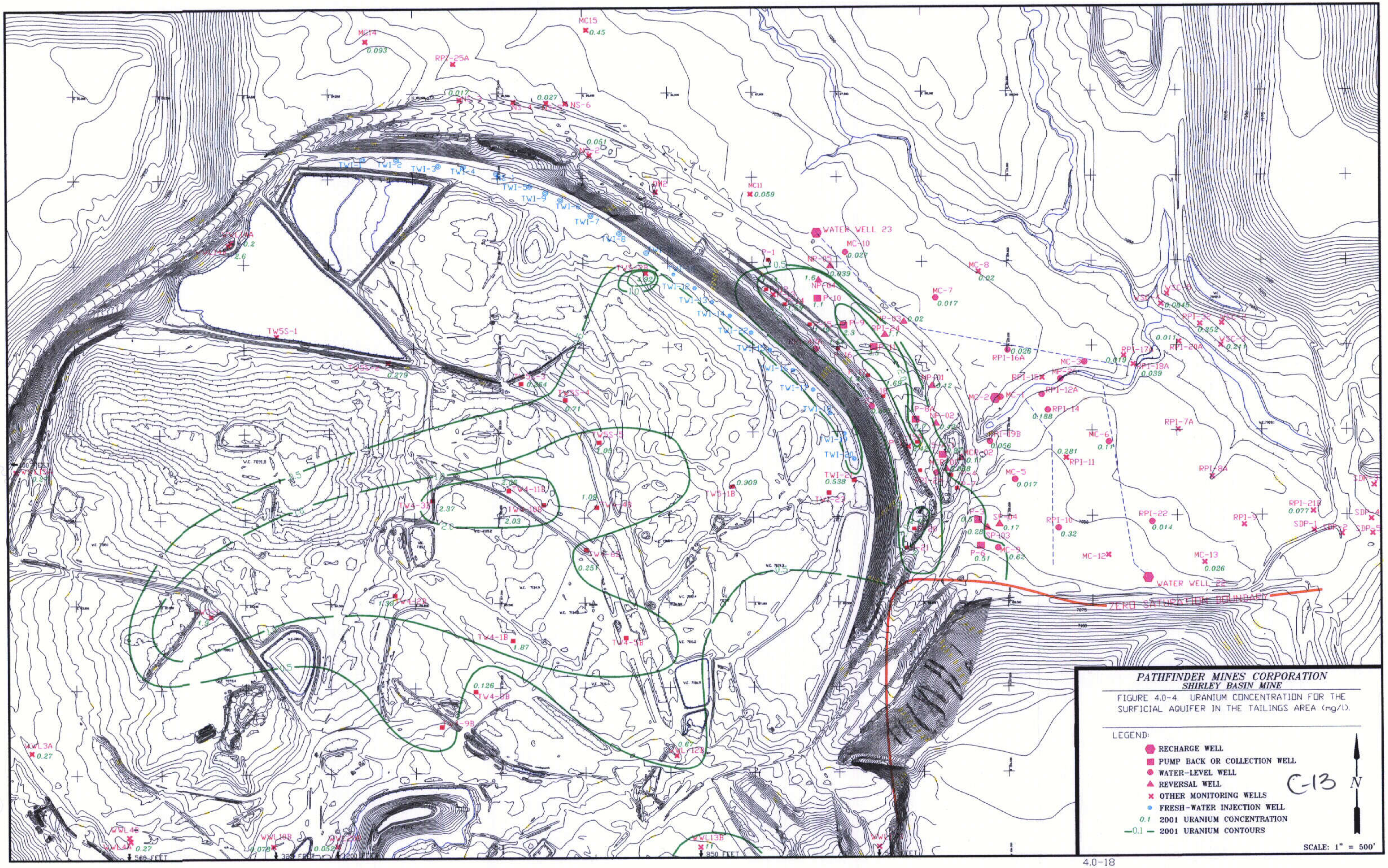
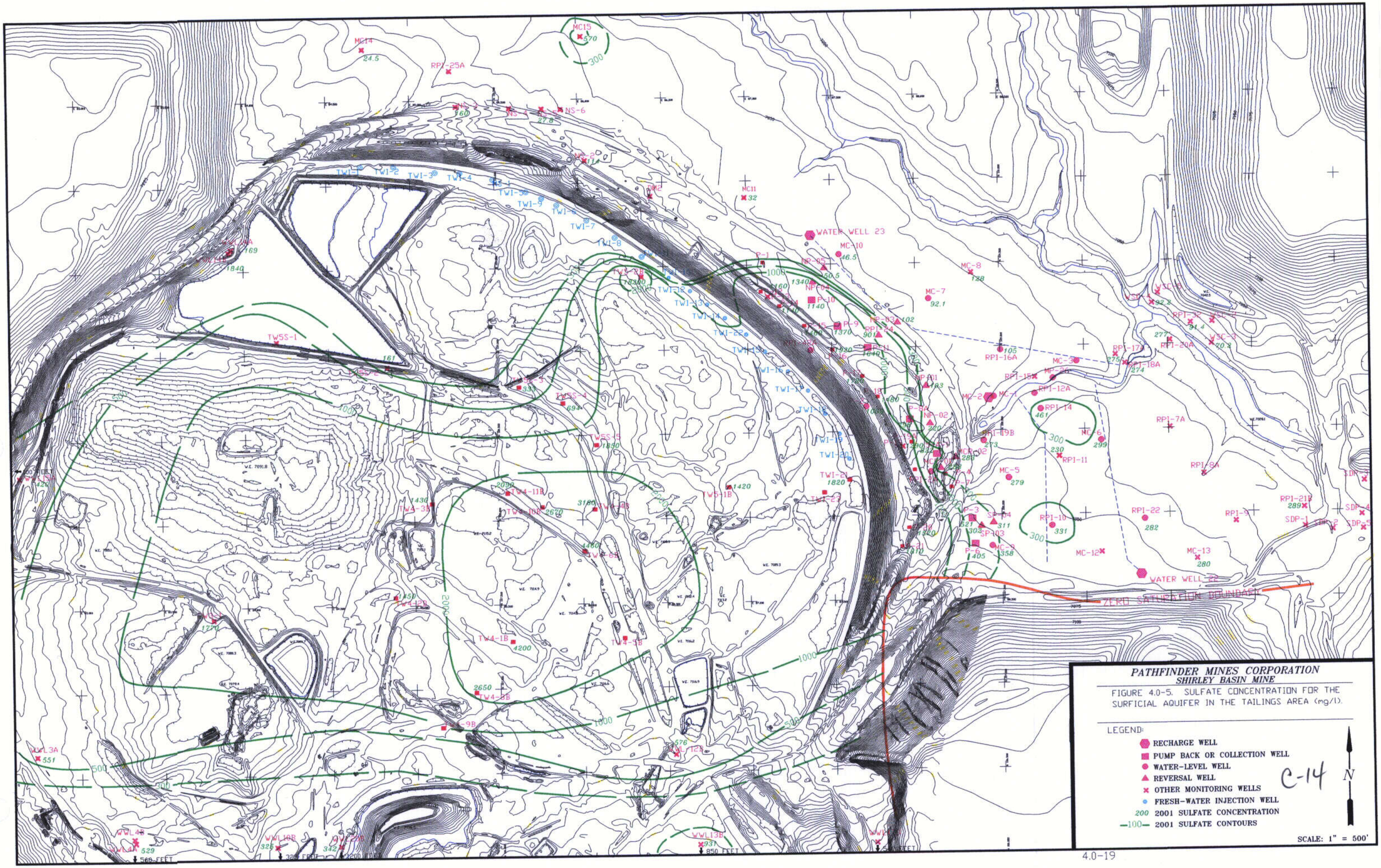


FIGURE 4.0-3. FIELD CONDUCTIVITY FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (umhos/cm @25 °C).



PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE
FIGURE 4.0-4. URANIUM CONCENTRATION FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (mg/l).
LEGEND:
RECHARGE WELL
PUMP BACK OR COLLECTION WELL
WATER-LEVEL WELL
REVERSAL WELL
OTHER MONITORING WELLS
FRESH-WATER INJECTION WELL
0.1 2001 URANIUM CONCENTRATION
—0.1— 2001 URANIUM CONTOURS
SCALE: 1" = 500'
N
C-13
ZERO SATURATION BOUNDARY
WATER WELL 23
WATER WELL 22



PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE

FIGURE 4.0-5. SULFATE CONCENTRATION FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (mg/l).

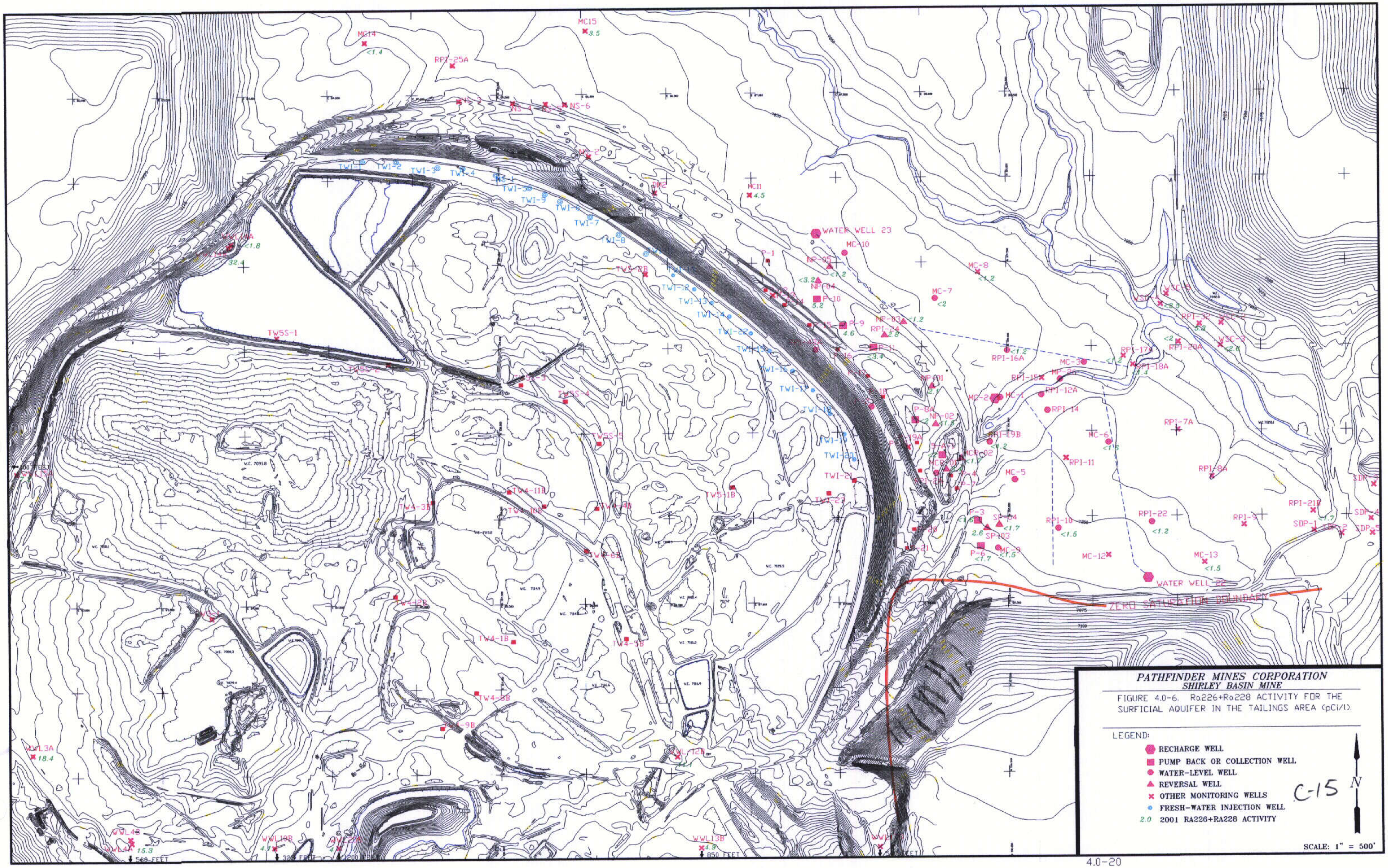
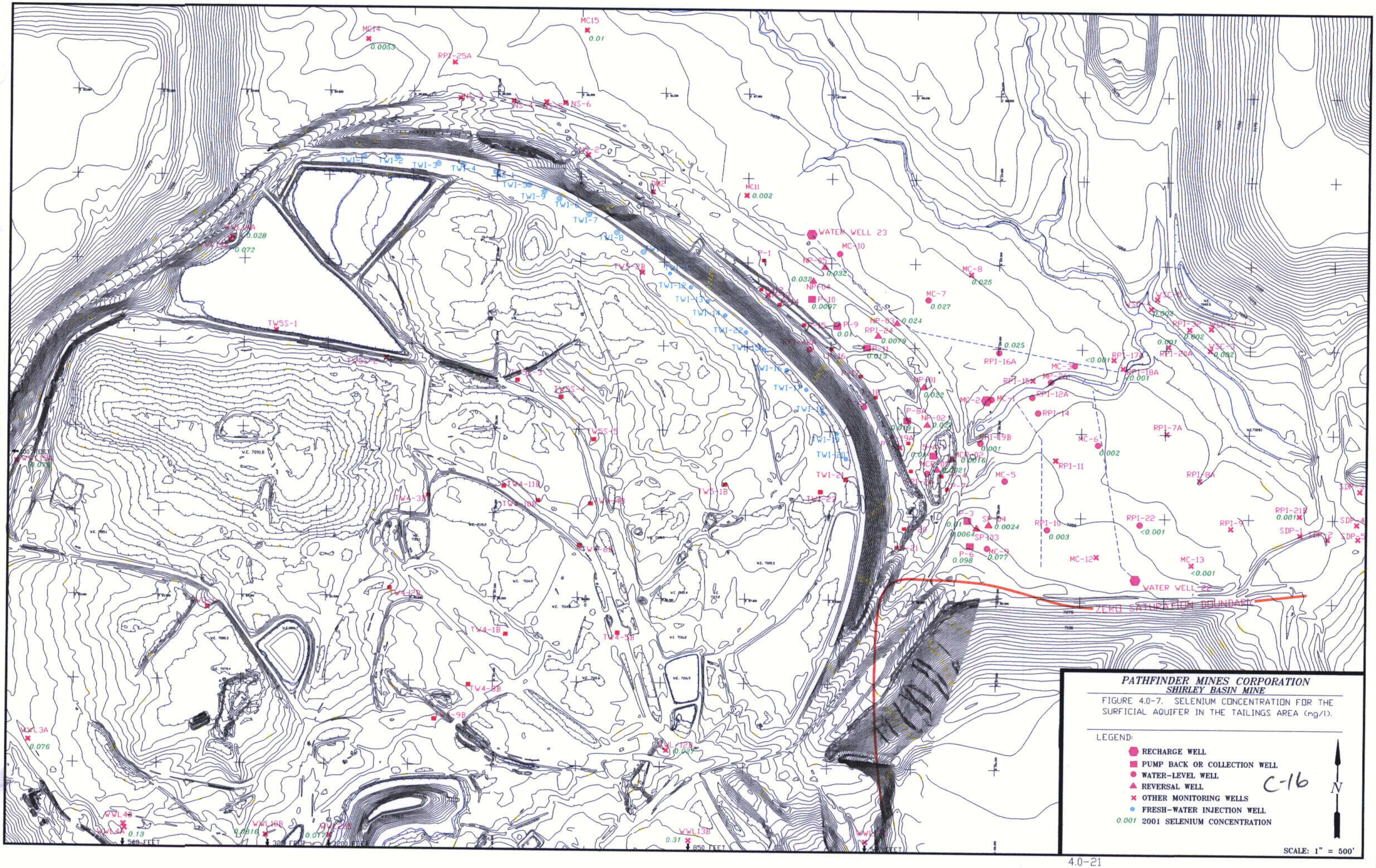
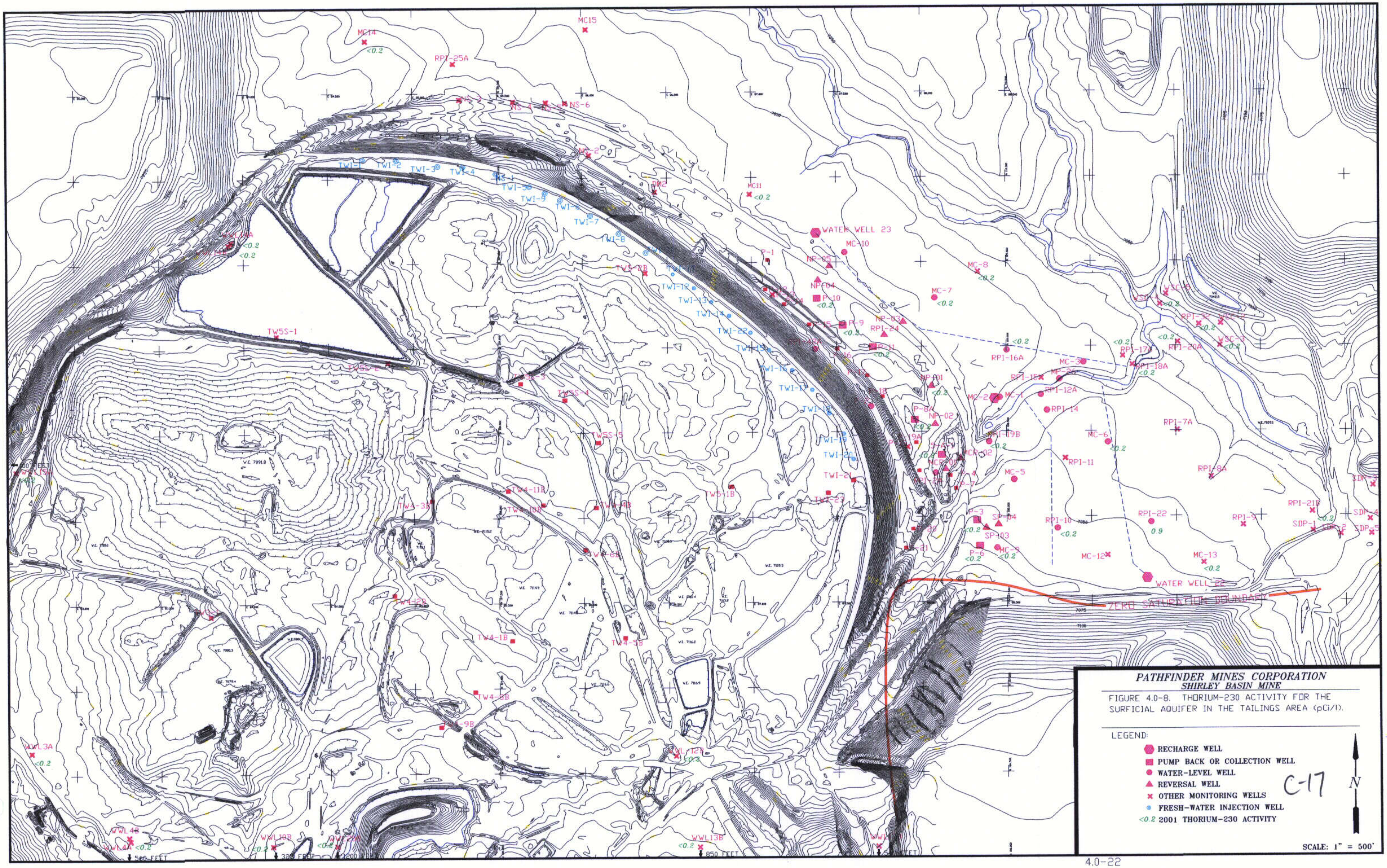


FIGURE 4.0-6. Ra226+Ra228 ACTIVITY FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (pCi/l).


PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE
FIGURE 4.0-7. SELENIUM CONCENTRATION FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (mg/l).
LEGEND:
RECHARGE WELL
PUMP BACK OR COLLECTION WELL
WATER-LEVEL WELL
REVERSAL WELL
OTHER MONITORING WELLS
FRESH-WATER INJECTION WELL
0.001 2001 SELENIUM CONCENTRATION
SCALE: 1" = 500'
N
C-16
ZERO SATURATION BOUNDARY
WATER WELL 23
WATER WELL 22


PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE
FIGURE 4.0-8. THORIUM-230 ACTIVITY FOR THE SURFICIAL AQUIFER IN THE TAILINGS AREA (pCi/l).
LEGEND:
RECHARGE WELL
PUMP BACK OR COLLECTION WELL
WATER-LEVEL WELL
REVERSAL WELL
OTHER MONITORING WELLS
FRESH-WATER INJECTION WELL
<0.2 2001 THORIUM-230 ACTIVITY
C-17
N
SCALE: 1" = 500'
WATER WELL 23
WATER WELL 22
ZERO SATURATION BOUNDARY
MC15
MC14
RPI-25A
MC11
MC-10
MC-8
MC-7
MC-6
MC-5
MC-13
MC-12
TW5S-1
TWI-1
TWI-2
TWI-3
TWI-4
TWI-7
TWI-8
WWL3A
WWL4B
WWL13B
850 FEET
500 FEET

4.1 NORTH MINE CREEK RECHARGE AREA

Most of the north Mine Creek recharge area downgradient of the recharge line shows vastly improved groundwater quality. Based on chloride concentration and TDS, these wells show water quality similar to recharge water from wells WW23 and WW20 (Table 4.1-1). The north plume aquifer downgradient of the recharge line is essentially free of contaminants. Efforts will continue to center on maintenance of strong reversal gradients and continuous operation of the recharge system. General water quality data taken upgradient of the recharge system shows very little change in 2001. Water quality in wells NP04 and NP05 improved dramatically following reestablishment of gradient reversal.

Concentrations of TDS and chloride downgradient of the north recharge line have stabilized at levels roughly equal to those of the recharge water. Well MC-11 is located northwest of the northern end of the recharge line, and both TDS and choride concentrations in the Surficial aquifer in this area have increased slightly over the last five years (see Figures 4.1-1 and 4.1-2) and there was a fairly abrupt increase in 1998 followed by a dramatic increase in mid-1999. Concentrations for samples in late 1999 dropped dramatically to levels consistent with those before the spikes and remained consistent through 2001. Prior to 1998, these changes were within natural variations for this aquifer. Chloride concentrations in well MC-11 had been somewhat erratic, and this was attributed to seasonal natural recharge prior to 1998. It is postulated that the injection well operation has pushed a small "pulse" of impacted ground water through the MC-11 area. TDS and choride concentrations at well NP05 have declined since 1997 due to reestablishment of reversal (see Figures 4.1-1 and 4.1-2). This decline continued through 2001.

Chloride and TDS concentration data correspond with the conductivity data for the north recharge area. Chloride concentrations for wells MC-7 and MC-8 are at background levels (see Figure 4.1-3). TDS concentration values appear to be representative of the mixed recharge water (see Figures 4.0-2 and 4.1-4).

TABLE 4.1-1. MONITOR WELL DATA COMPARED TO RECHARGE WATER DATA.

RECHARGE WATER	2001 DATA TDS	2001 DATA CHLORIDE
WW23	302 (11-08-2001)	15.3 (11-08-2001)
WW20	645 (11-08-2001)	13.9 (11-08-2001)

MONITOR WELLS	2001 DATA TDS	2001 DATA CHLORIDE
MC-7	397 (10-24-2001)	13.0 (10-24-2001)
MC-8	476 (9-27-2001)	17.9 (9-27-2001)

NOTE: All concentrations in mg/l.

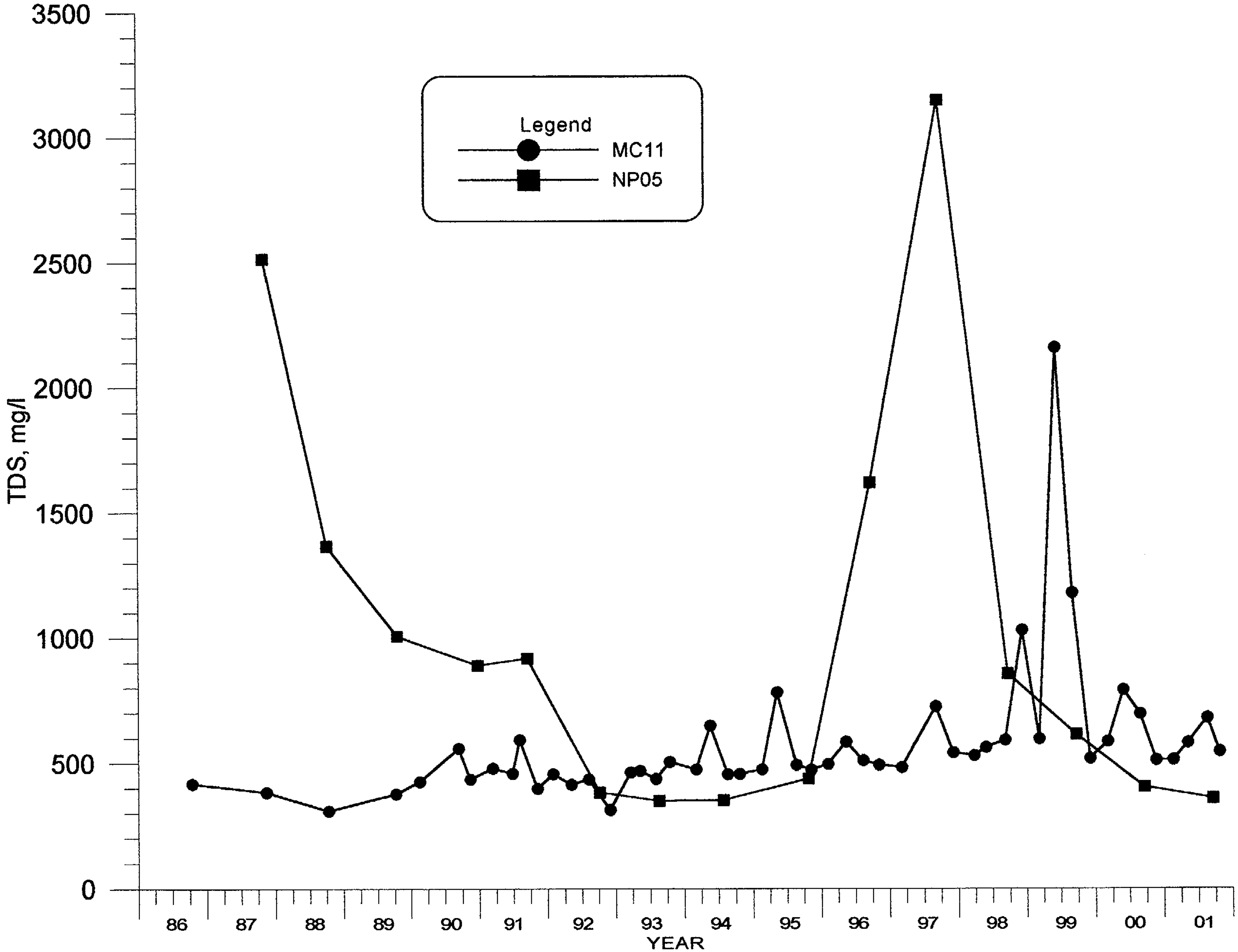


FIGURE 4.1-1. TDS CONCENTRATIONS FOR WELLS MC11 AND NP05.

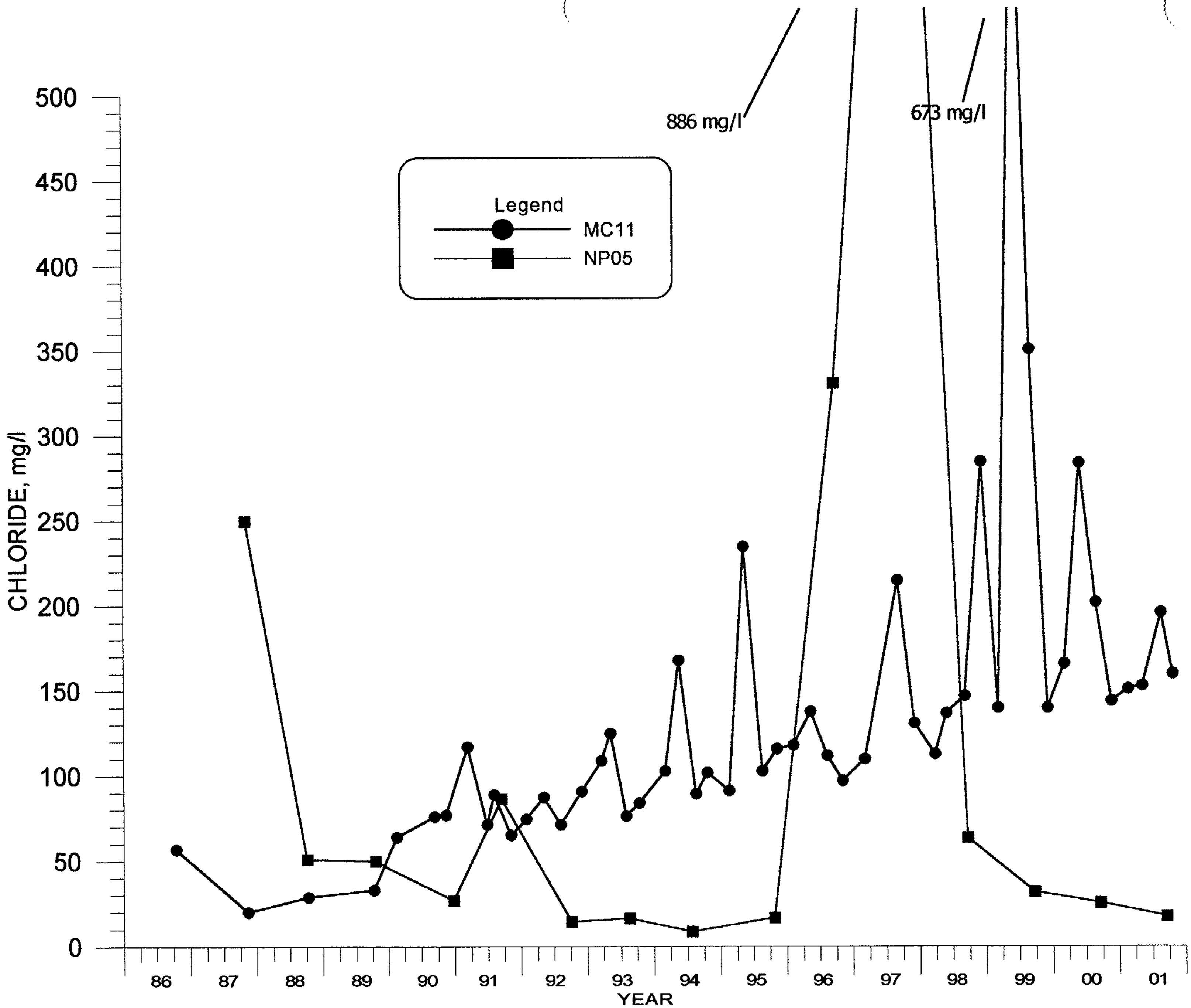


FIGURE 4.1-2. CHLORIDE CONCENTRATIONS FOR WELLS MC11 AND NP05.

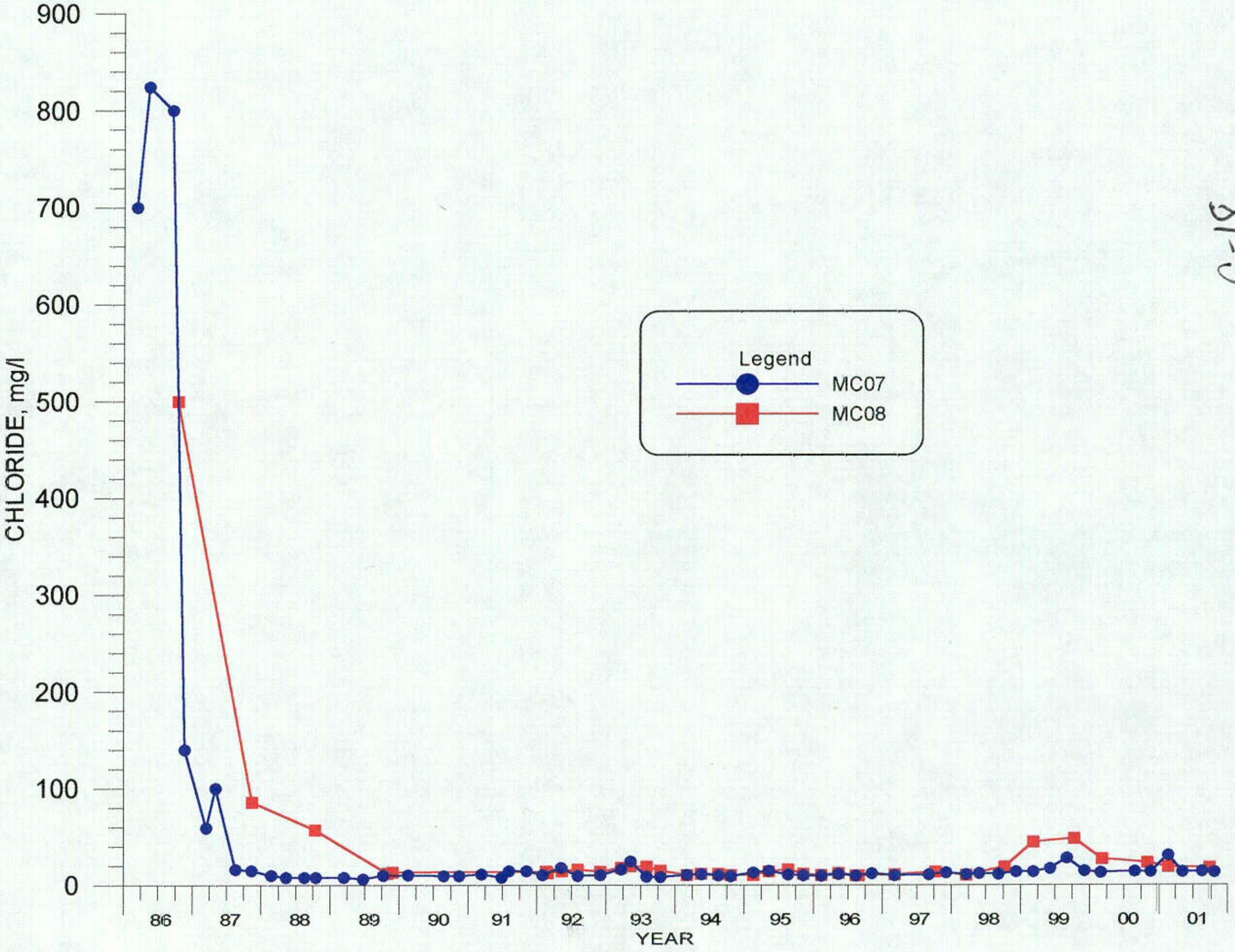


FIGURE 4.1-3. CHLORIDE CONCENTRATIONS FOR WELLS MC07 AND MC08.

C-18

C-

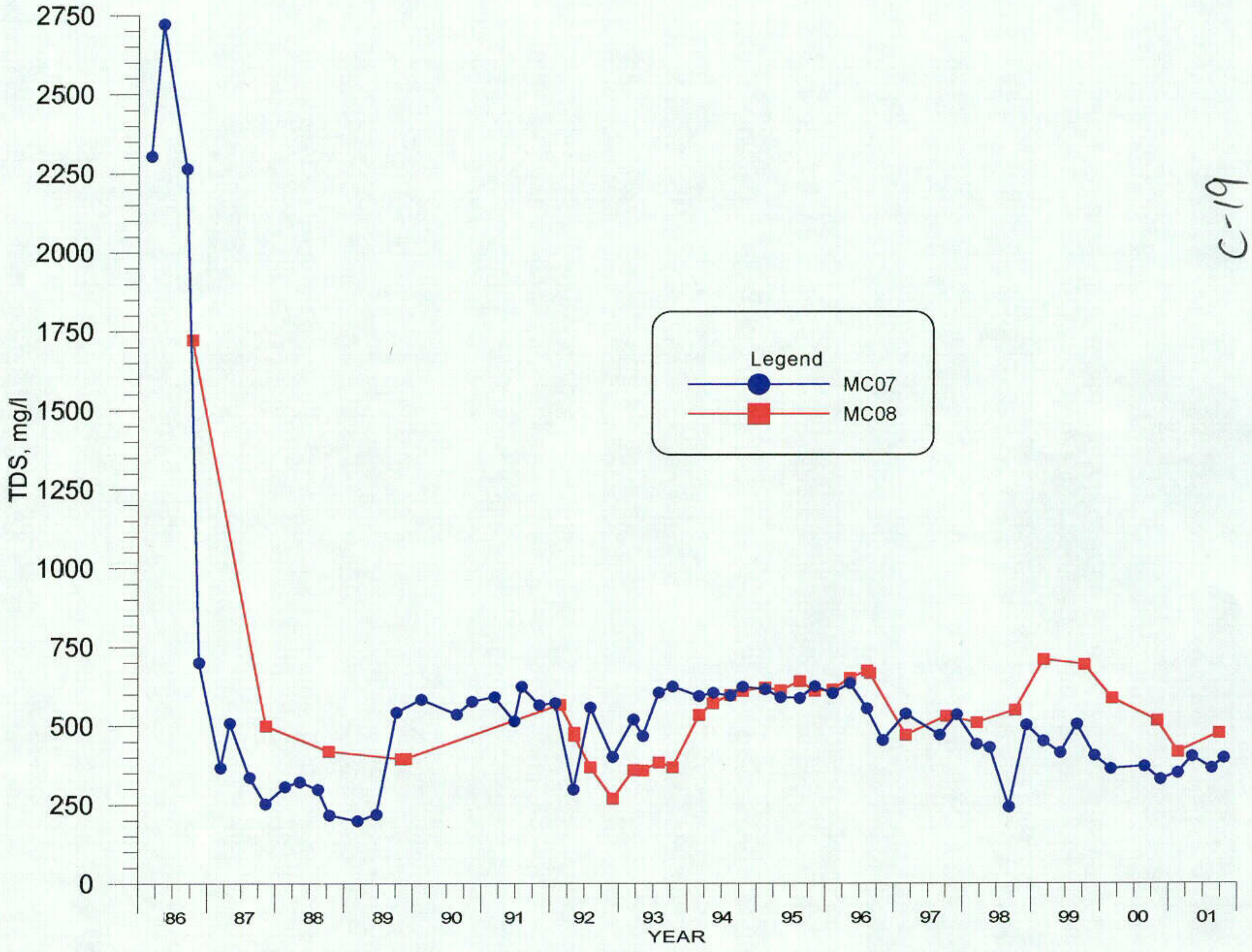


FIGURE 4.1-4. TDS CONCENTRATIONS FOR WELLS MC07 AND MC08.

C-19

C-

4.2 SOUTH MINE CREEK RECHARGE AREA

The water quality in wells east of the recharge lines for the south Mine Creek recharge area has been restored to nearly background conditions. Figure 4.2-1 shows that the TDS values in wells RPI-9 and RPI-21B have been reduced to essentially the recharge water concentration. The August 1996 analysis for well RPI-21B is thought to be anomalous.

Monitor well data from RPI-22, RPI-21B and MC-13 show restoration occurred prior to 1990 (see Figure 4.2-2). Wells RPI-7A, RPI-8A and RPI-9 had previously been used as indicator wells for the success of restoration of this area, but sampling in these wells was discontinued after data indicated restoration was essentially complete in 1992.

Figure 4.0-1 illustrates that the recharge/collection system has nearly restored the Surficial aquifer water quality to within a few hundred feet of the collection system. Water quality on the east side of the recharge lines shows only very minor residual elevation of constituent concentrations above recharge or background conditions. Water quality west of the recharge lines will continue to improve as the fresh water mound expands. There are some elevated TDS or chloride values at wells MC-6, RPI-11 and RPI-14, and it is speculated that this is a result of flushing of previously stagnant areas of the aquifer, and possibly solublization of constituents with a cycling water table. The gradient towards the tailings and water quality of wells RPI-19B and MC-5 indicate that the slightly elevated concentrations in wells RPI-11, RPI-14 and MC-6 are not a result of continued seepage from the tailings.

The rate of restoration of the Surficial aquifer to the west of the south recharge line increased dramatically in 1996, but the rate of restoration slowed during 1997 and the concentrations have essentially remained the same for the last several years. Water quality in well RPI-10 improved quickly with the new recharge and is essentially restored to background conditions. Gradient reversal between wells RPI-11 and MC-5 was strengthened significantly in 1996 and remains strong. The slow restoration progress in these wells prior to 1996 was considered to be indicative of lower transmissivity in this area and the difficulty in achieving a strong gradient reversal. The addition of a recharge line in the south area has been very successful in restoring water quality in this area. Figure 4.2-3 presents the TDS concentrations in wells MC-9, SP03 and SP04.

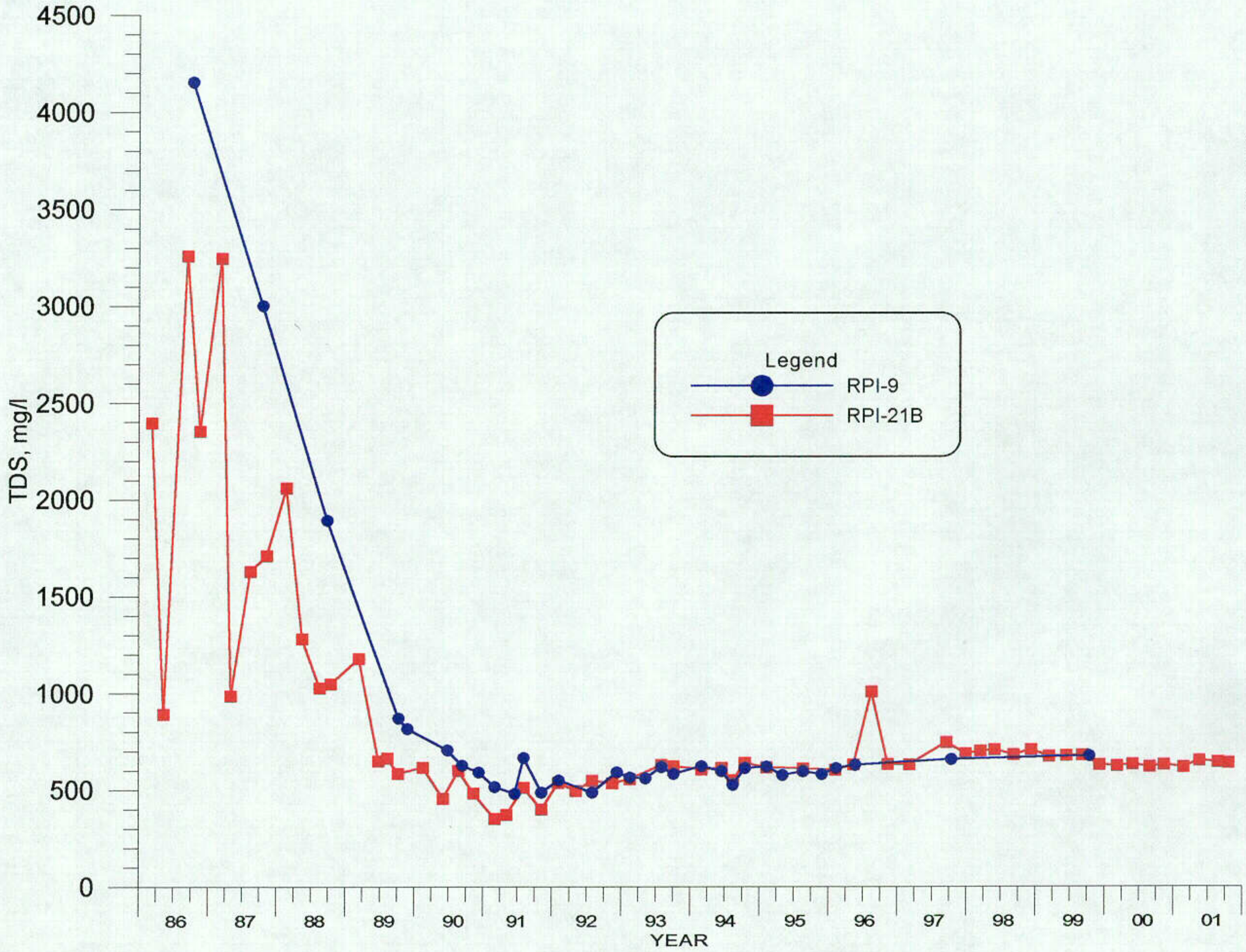
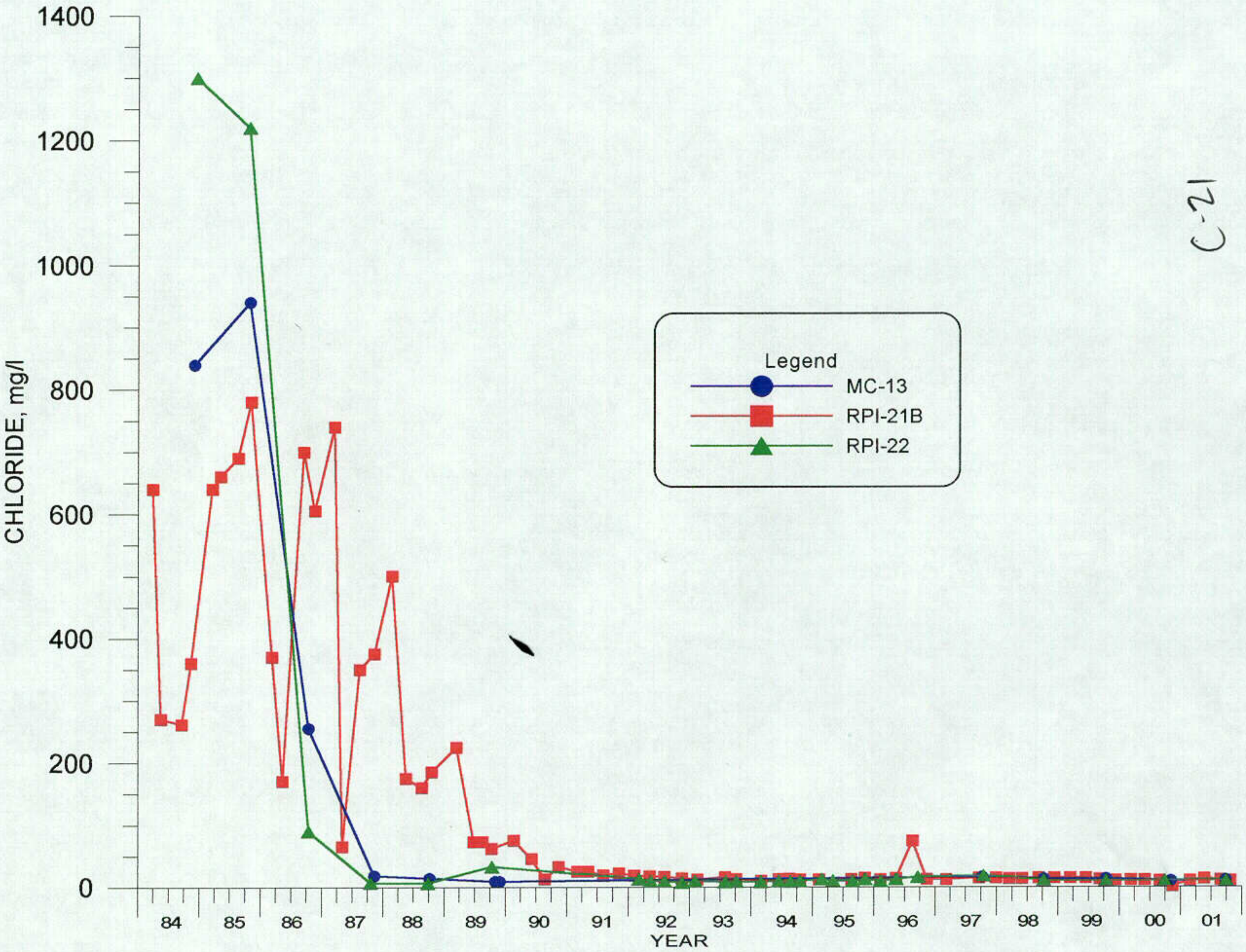


FIGURE 4.2-1. TDS CONCENTRATIONS FOR WELLS RPI-9 AND RPI-21B.

C-20



C-21

FIGURE 4.2-2. CHLORIDE CONCENTRATIONS FOR WELLS MC-13, RPI-21B AND RPI-22.

C-

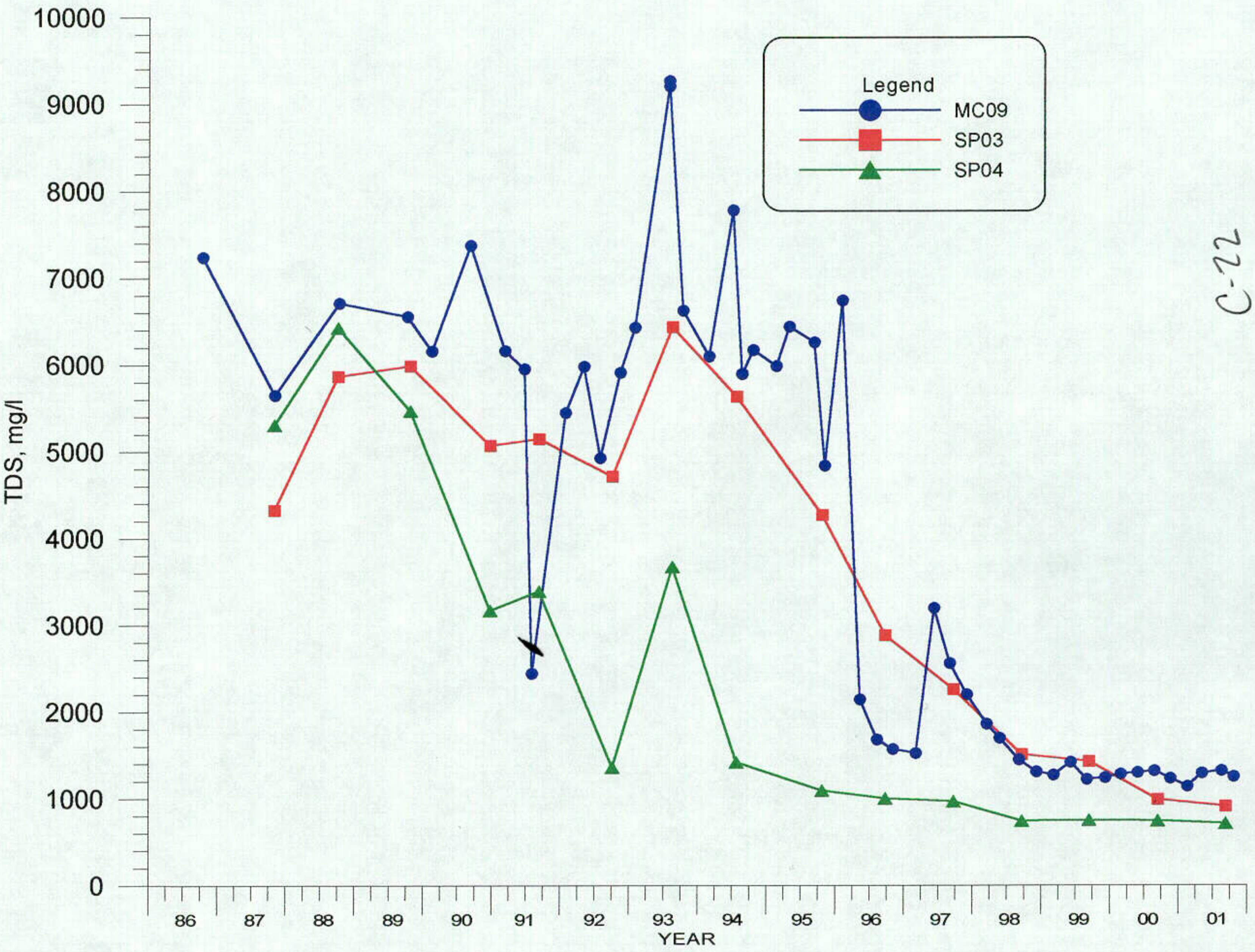


FIGURE 4.2-3. TDS CONCENTRATIONS FOR WELLS MC09, SP03 AND SP04.

C-22

4.3 MINE CREEK CHANNEL AREA

Contaminant concentrations in monitor wells RPI-19B, MCR02, and MCR01, are considered indicative of the effectiveness of collection/recharge efforts in the Mine Creek area. Figure 4.3-1 presents the chloride concentrations for wells RPI-19B and MCR02. The ground-water quality in this area is essentially restored and there are only very modest declines in constituent concentrations.

Contaminant concentrations in the Surficial aquifer of the lower Mine Creek area have been significantly affected by the recharge lines. Figure 4.3-2 illustrates that TDS concentrations in wells RPI-17A and RPI-18A have been relatively stable for over nine years, while well RPI-20A has shown a modest but consistent decline over the same period and is now at similar TDS levels.

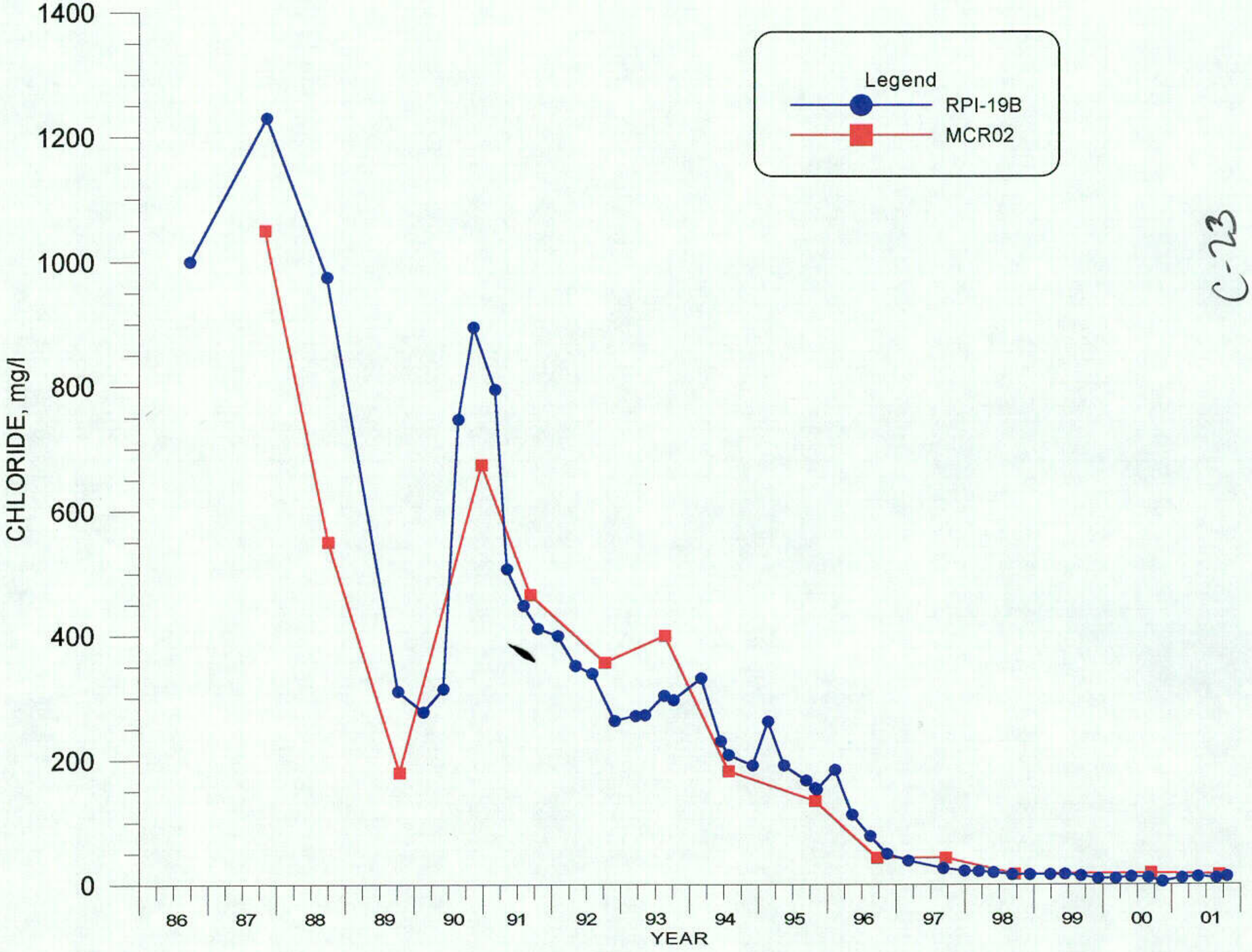


FIGURE 4.3-1. CHLORIDE CONCENTRATIONS FOR WELLS RPI-19B AND MCR02.

C-

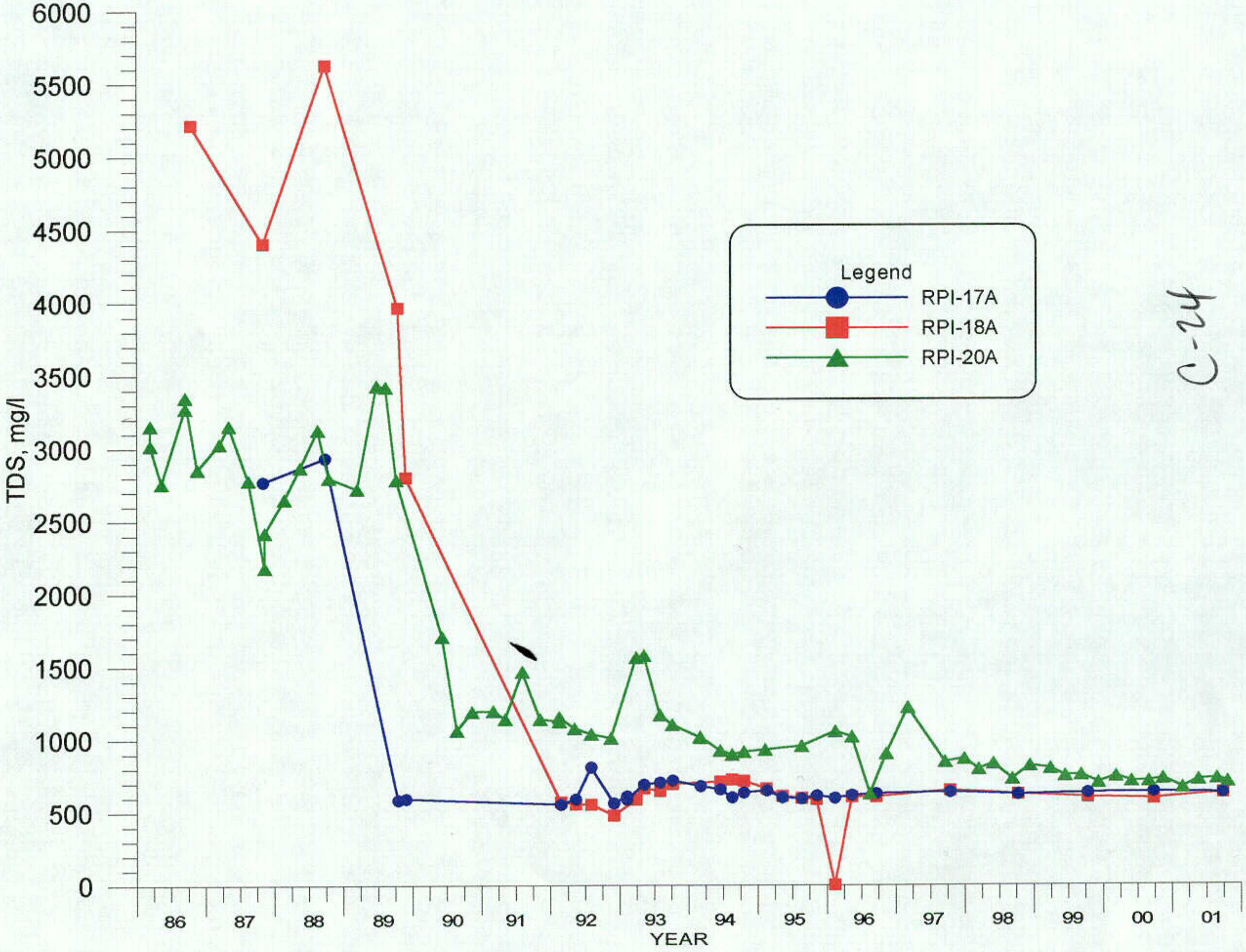


FIGURE 4.3-2. TDS CONCENTRATIONS FOR WELLS RPI-17A, RPI-18A AND RPI-20A.

C-

4.4 NORTH INJECTION WELL AREA

An injection and monitoring well system for the northern perimeter of the No. 5 dam was installed in 1994. Water quality samples were taken from wells to monitor the performance of this system. The data in Tables A-1 and A-2 of Appendix A and Figures 4.4-1 and 4.4-2 indicate some changes in the water quality of wells NS-2 and MC-15 that are thought to reflect the influence of injection water. The recent water quality changes in well MC15 also indicate a seasonal cycling. A four-year overall declining trend in TDS concentration for well MC15 through 2001 (see Figure 4.4-2) indicates that restoration is progressing.

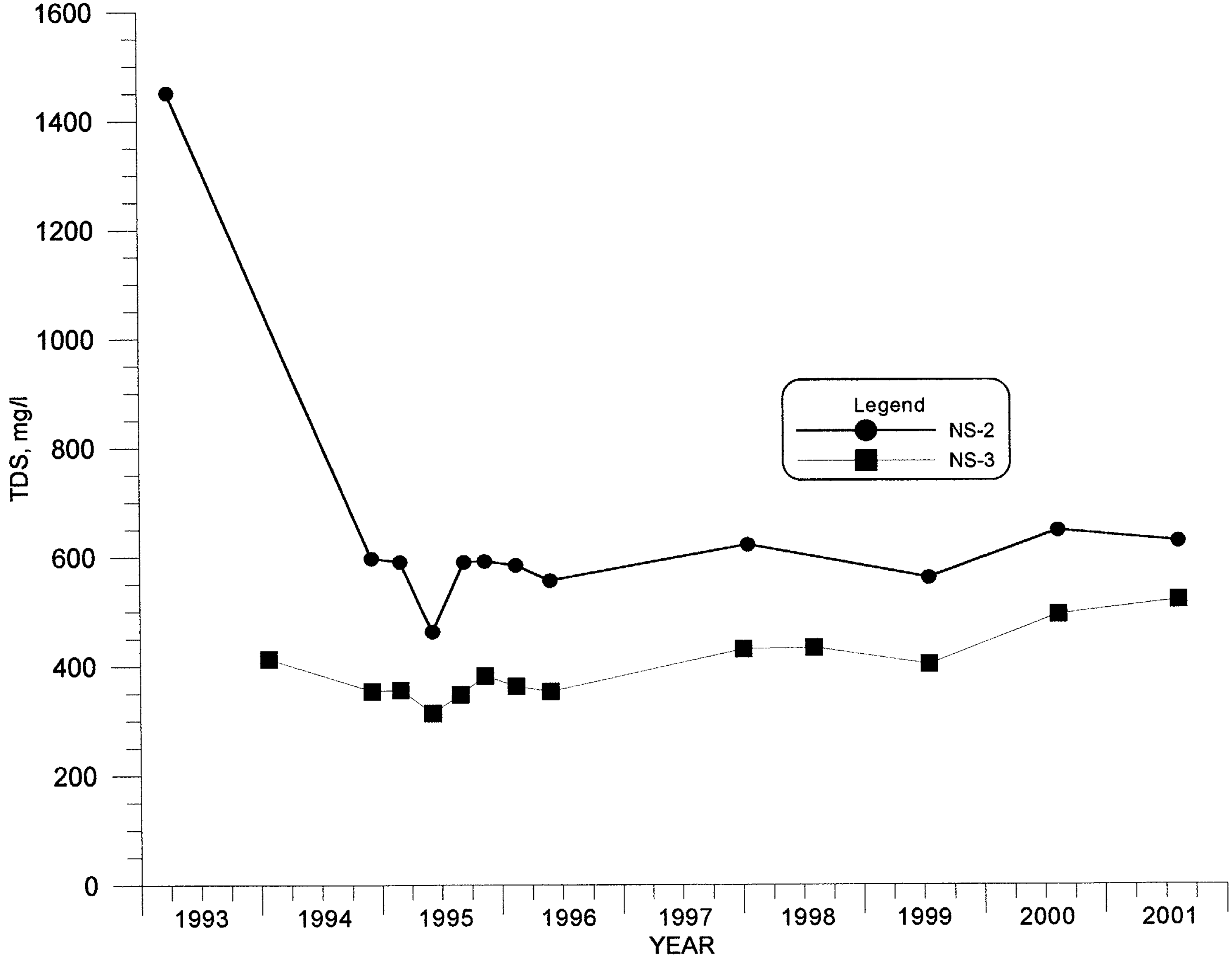


FIGURE 4.4-1. TDS CONCENTRATIONS FOR WELLS NS-2 AND NS-3.

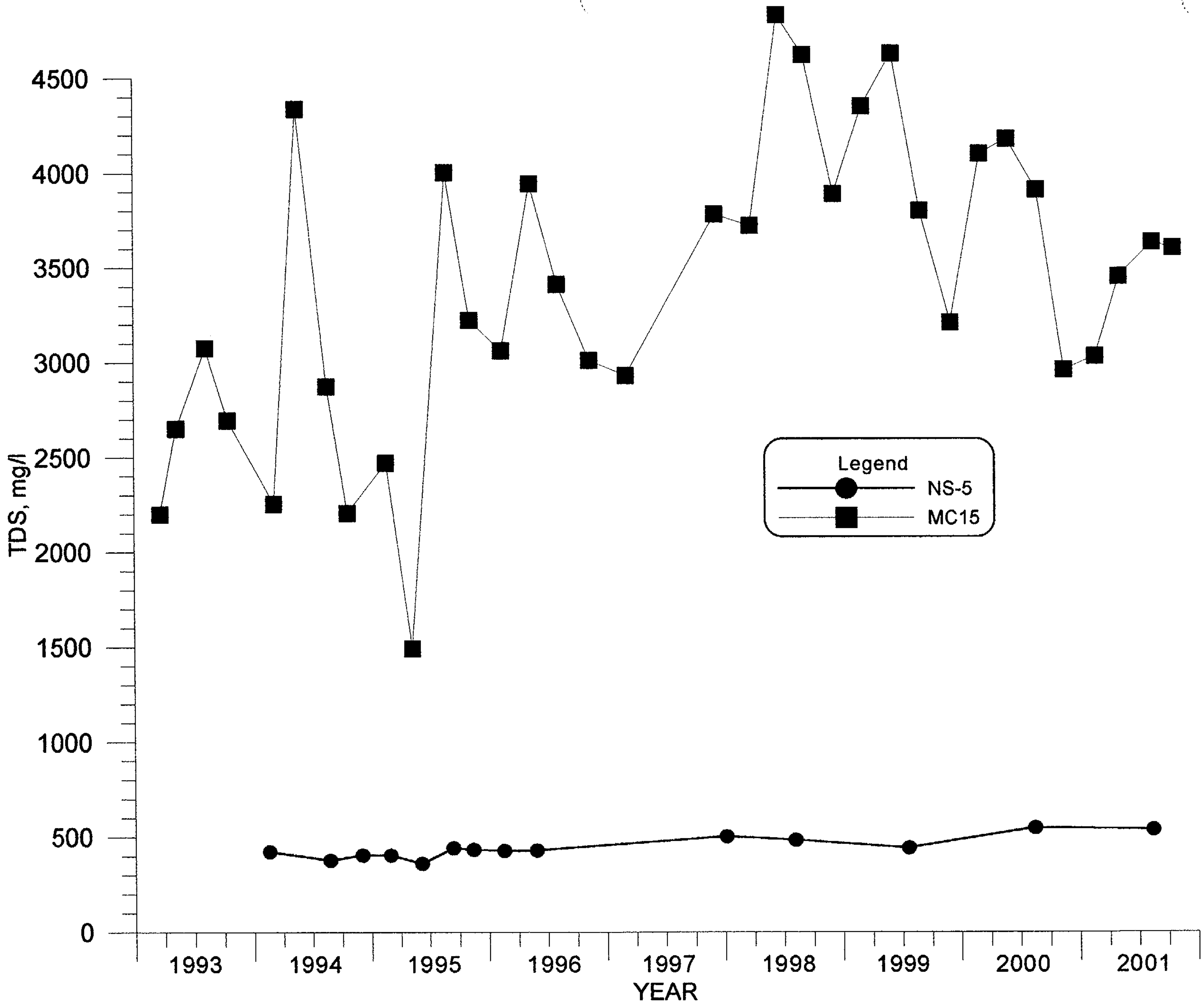


FIGURE 4.4-2. TDS CONCENTRATIONS FOR WELLS NS-5 AND MC15.

4.5 GENERAL TAILINGS AREA

The water quality in the Surficial aquifer to the west and south of the tailings impoundments varies widely. Water quality data for this area is presented in Tables A-1 and A-2 of Appendix A. Within the immediate area of the tailings, all Surficial aquifer wells show seepage effects. These effects range from relatively mild contamination at injection well TWI-3 on the northern perimeter of the tailings impoundment, to severe contamination at well TW4-5B. During 2001, two immediate tailings area wells showed a dramatic worsening in water quality. The wells are TW5-2B and TW4-9B and both exhibited anomalous results in specific constituents for samples taken in mid 2001. An additional sample was recently taken from well TW5-2B and the field pH and conductivity are not consistent with the 7/20/2001 sample (where the field conductivity was very low when contrasted with other parameters). The laboratory analysis for the recent sample is not complete, but the field water quality measures are more consistent with historic data and the 7/20/2001 sample is considered suspect. Weather conditions have prevented additional sampling of well TW4-9B, but the results of the 7/18/2001 sampling are highly suspect. The field pH is much lower than past measurements, while TDS and field conductivity are consistent with historic samples. The low pH in combination with a dramatic increase in sulfate concentration and a contrasting dramatic reduction in chloride concentration could indicate a sample misidentification. The grossly elevated uranium concentration for this sample was reviewed by the laboratory, but there was no remaining sample to recheck. Given that the uranium concentration in this sample was substantially greater than that in adjacent tailings wells TW4-9C and TW4-9CA, the value is not plausible. An additional sample will be taken from this well as soon as weather permits, and the results will be used to determine if the 7/18/2001 sample data are usable.

Contamination at well WWL-3A appears to be mild to moderate, and the water quality had been relatively consistent until the conductivity measurement of 1996. There is likely some remnant contamination at this well.

Well WWL-10B on the southwest side of the tailings appears to be unaffected by tailings seepage, although the data is somewhat erratic. Much of the recharge for this well likely comes through mine spoil materials, and the erratic nature of the water quality is likely a result of seasonal or cyclic recharge. Well WWL-12B shows mild to moderate seepage impacts. Well WWL-13B, which is located south of the former mill location shows elevated concentrations which likely result from activity in the mill area. Figures 4.5-1 and 4.5-2 present the TDS and chloride concentrations, respectively, for wells WWL-12B and WWL-13B. Seepage impacts in well WWL-12B have gotten progressively worse over the period of record and this well is probably affected by both tailings seepage and mill area activity. While both chloride and TDS concentrations in well WWL-13B have changed over the period of record, there is a readily discernible trend only for TDS. This tends to indicate that the source is local, and that cessation of mill related activities may allow natural processes to alleviate the contamination.

Data for well WWL-15A west of the tailings indicate mild to moderate seepage impacts with a distinct deteriorating trend in water quality in recent years. Well WWL-20B is located south of the tailings, and has shown relatively mild impacts, that are not thought to be related to the tailings (Figure 4.5-3). The tailings are located downgradient of well WWL-20B and it is unlikely that this gradient has been reversed strongly enough to cause movement to this well.

With the exception of the 2001 sample in well WWL-4A, wells WWL-4B and WWL-4A do not appear to be impacted by seepage based on chloride, TDS and uranium concentrations. The 2001 sample in well WWL-4A exhibited appreciably higher concentrations of chloride, sulfate, TDS and uranium. Well WWL-4B has been dry for several years, and the water level elevation in well WWL-4A is declining. Radium 226 activities for these wells as noted in Table A-1 are very erratic and elevated. Radium 226 has proven to be nearly immobile in the tailings area. The presence of radium 226 at high levels in these wells without attendant major ions usually associated with tailings seepage is a strong indication that the wells are affected by a source other than tailings seepage. Well WWL-4B had very limited saturation in a shallow sand prior to going dry, and the saturation in well WWL-4A is less than 9 feet and this well has proven difficult to sample due to a very poor yield. The source of the radium 226 is unknown, but the historic records indicates that it is not associated with tailings seepage. The recent elevated concentrations of major ions could indicate some seepage impact from tailings, but due to the location of these wells, the seepage would be moving cross gradient at very slow rates, and this is considered unlikely.

Chloride concentrations for the remainder of the tailings area indicate moderate seepage effects for the Surficial aquifer beneath much of the No. 4 Tailings pond, the No. 5 Tailings pond, and extending through the No. 3 Solution pond area. With the exception of well MC-15, the seepage impacts to the north of the tailings are very mild and are contained relatively close to the tailings. On the northwest side of the tailings, Surficial aquifer wells WWL-14A and WWL-14B exhibit mild to moderate contamination. Well WWL-14A is believed to be a representative Surficial aquifer well and showed almost no indication of seepage impacts until 1996, when water quality deteriorated significantly. The 2001 water quality data for this well indicate no substantial change. One possible explanation for this change in water quality is that the nearby injection well operation has altered gradients and pushed seepage affected water to this well. If this is the case, eventual termination of injection/collection efforts will reduce gradients and will likely leave this area as a relatively stagnant portion of the Surficial aquifer. Well WWL-14B is believed to be representative of a perched zone above the Surficial aquifer. The water level indicates nearly direct recharge from nearby evaporation ponds and spray systems, and the water quality is correspondingly impacted. Water quality in well WWL-14B deteriorated appreciably in 2001 and the water level elevation in this well also increased significantly. This is likely due to the full utilization of the nearby evaporation pond. The water level elevation in well WWL-14B is more than 40 feet higher than the adjacent Surficial aquifer well and this is a further indication that the well sampling a shallow perched zone. The poor water quality also indicates fairly direct hydraulic communication with the adjacent evaporation pond.

The evaporation pond was constructed with clay, but there appears to be sufficient seepage to affect the nearby well. Well WWL-14B will be sampled again as soon as weather permits to confirm the fairly dramatic changes in water quality.

Figure 4.0-2 presents the TDS contours for the Surficial aquifer near the tailings for 2001. In the Mine Creek area, TDS concentration contours closely resemble the chloride concentration contours. In the remainder of the tailings area, the chloride and TDS contours indicate a similar degree of seepage impacts and progress in restoration of the Surficial aquifer water quality.

The latest field conductivity data for the Surficial aquifer near the containment system are presented in Figure 4.0-3. There is a modest improvement in water quality in the collection area east of the tailings and a modest deterioration of water quality in the Surficial aquifer beneath the tailings indicated by the field conductivity. The conductivity contours resemble those of chloride and TDS concentrations.

Uranium concentrations in the Surficial aquifer tend to reflect the presence of some areas with characteristics that enhance uranium mobility. The zone of greatest uranium concentration is immediately around the Mine Creek area collection wells (Figure 4.0-4). Uranium concentrations are not particularly large anywhere in the Surficial aquifer, and the neutralization of tailings seepage as it enters the Surficial aquifer dramatically reduces the uranium solubility. This neutralization occurs as a result of a calcite dissolution/gypsum precipitation process that was first identified in 1979. When it reaches the Surficial aquifer at a reduced concentration, uranium appears to be somewhat selectively mobile, particularly when compared to the level of contamination indicated by chloride and TDS. It is postulated that there is a combination of pH and the presence of carbonates in the formation that impacts the mobility of uranium in specific areas. In combination with some retardation processes (e.g. adsorption/desorption), the geochemical processes alter the movement of uranium in the Surficial aquifer when compared to more conservative constituents. The extent of seepage impacts is very similar to other constituents, but the apparent severity of impacts does not necessarily correspond with that indicated by other constituents. In general, uranium concentrations have decreased slightly during 2001 throughout the tailings area. Well WWL-13B exhibits anomalously high uranium concentrations, and this is believed to be a local phenomenon related to mill area activity.

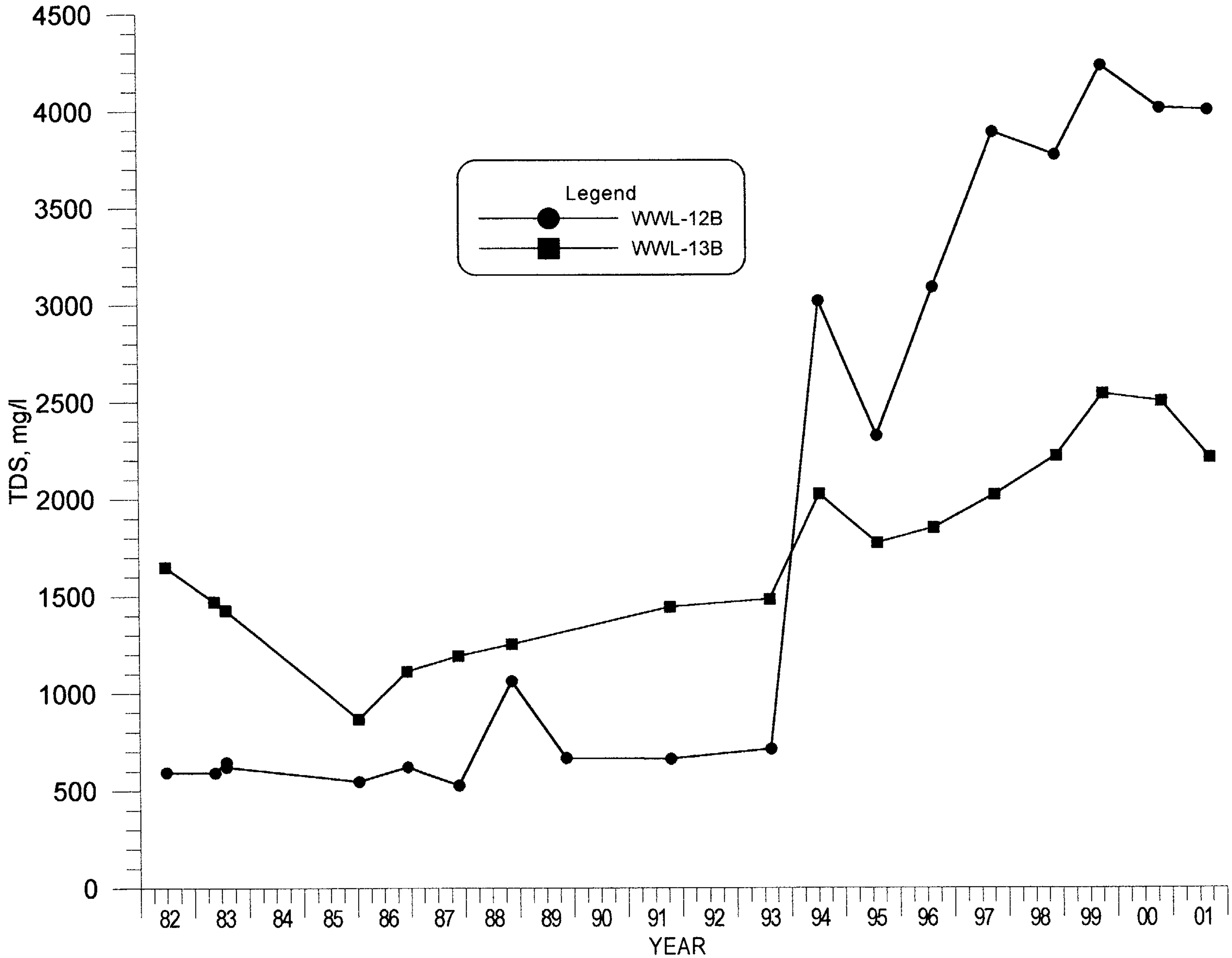


FIGURE 4.5-1. TDS CONCENTRATIONS FOR WELLS WWL-12B AND WWL-13B.

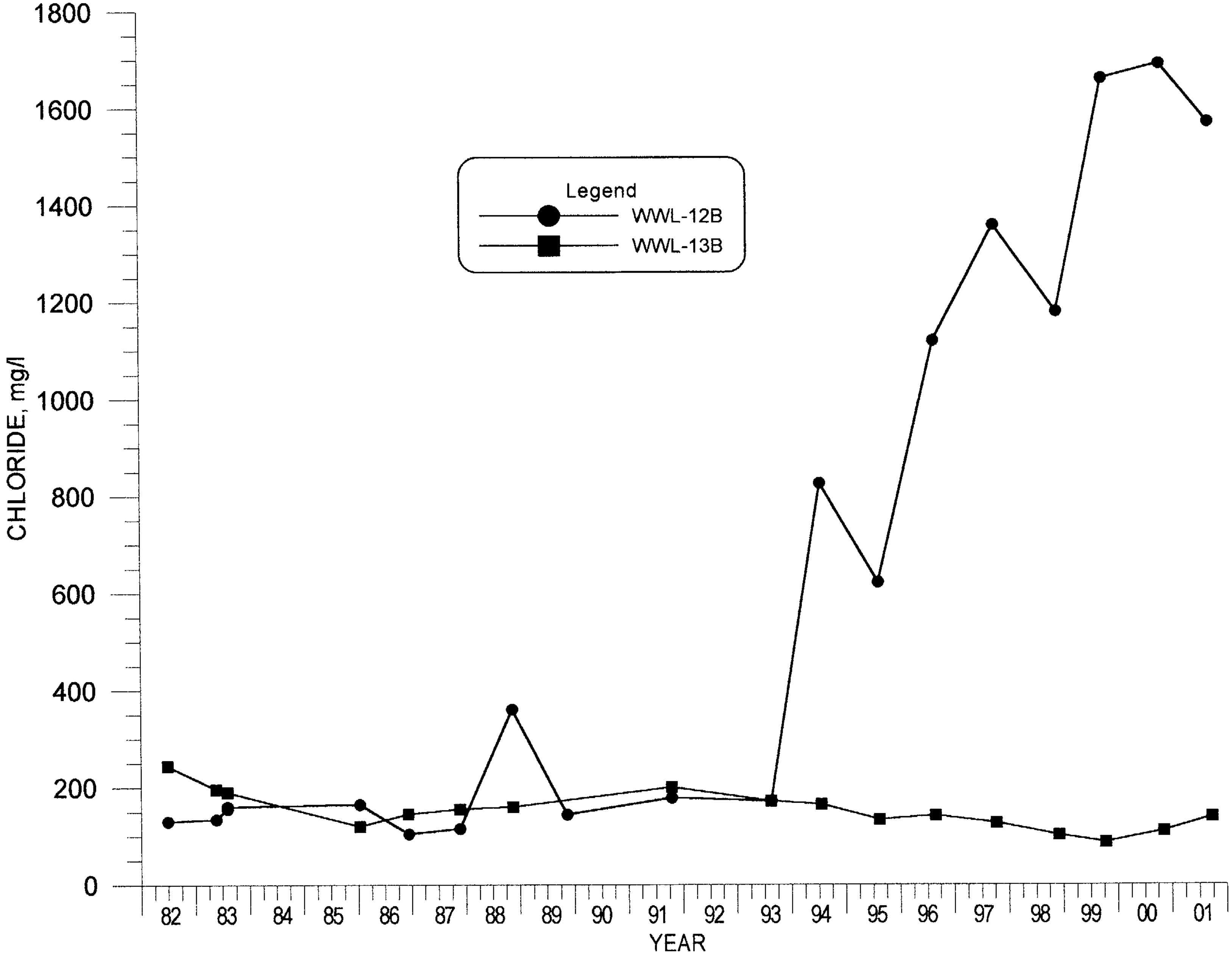


FIGURE 4.5-2. CHLORIDE CONCENTRATIONS FOR WELLS WWL-12B AND WWL-13B.

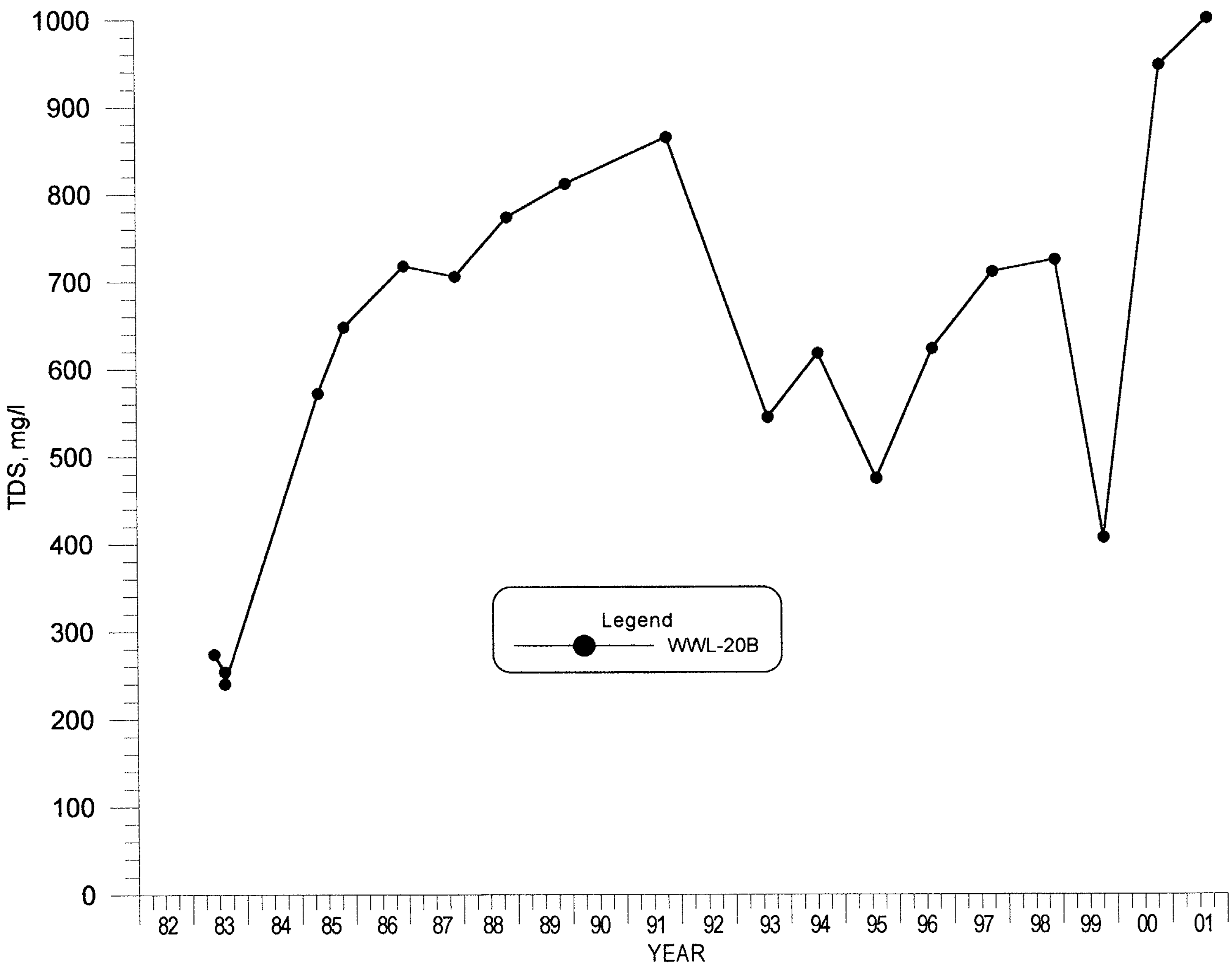


FIGURE 4.5-3. TDS CONCENTRATIONS FOR WELL WWL-20B.