URS

Construction Services

October 9, 2000

Ms. Kathy M. Kinton
Senior Environmental Planning Engineer
Miller Brewing Company
3939 Highland Road
Milwaukee, WI 53201-0482

Re: Permeable Reactive Wall Pilot Test Results for First Five Sample Rounds, Former Miller Container Plant, Fulton, NY

Dear Ms. Kinton:

URS is pleased to present this summary of the Former Miller Container Plant permeable reactive wall (PRW) pilot test results for the first five rounds of groundwater sampling. The results suggest that the PRW pilot test will be successful. The data fall into three distinct groups that can be used to evaluate the performance of the PRW pilot wall:

1. Geochemical

2. Hydraulic

3. Volatile Organic Compound (VOC)

These three data sets are discussed below. Please note that the data for the first two sample rounds were collected with recovery well RW-2 in operation. Pumping at RW-2 would tend to make the PRW look less effective due to increased velocity through the PRW and decreased residence times.

Geochemical Results

Geochemical monitoring results are shown in Figure 1. Of particular interest are the oxidation-reduction potential (ORP) results summarized in Table 1 and Figure 2. ORP is a significant indicator of the effectiveness and success of the iron in treating the contaminants of concern at the site. Generally, when the PRW develops full effectiveness there are strongly reducing conditions and ORP within the wall is in the –200 to –400 mV range. The data are grouped into upgradient, above wall, mid-wall, and downgradient locations below for easier review.

The mid-wall and downgradient wells (PZ-4, GEO-2, and PZ-2, GEO-1, GEO-3 respectively) show a continuing trend from positive to negative ORP and currently range from about –108.2 to –166.3 mV. The most strongly reducing conditions were observed in the mid-wall monitoring points PZ-4 and GEO-2, -129.6 and –166.3 respectively. This is a strong indicator that the iron is working as it should, and suggests that the iron is successfully degrading the VOCs in the groundwater that contacts the PRW.

Upgradient piezometers PZ-1, PZ-3, and PZ-6 initially have negative ORP. This suggests they may have been impacted by the iron injection. Likewise the ORP measured in piezometer PZ-6 was negative in the second round of sampling, and may have been impacted. The ORP in these wells does not exhibit a clear trend but tends to be moving from positive to negative. This may be the result of hydraulic conditions that are flat and vary somewhat across the PRW from upgradient piezometers PZ-1 and PZ-3 to the downgradient piezometer PZ-4. Because of the close proximity of the upgradient piezometers PZ-1, PZ-3 and PZ-6 to the PRW (about 8 feet) the negative ORP in these piezometers may also be the result of an ORP shadow that is typical of zero-valent iron PRWs.

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The above wall well PZ-5 follows a positive ORP trend until the last sample round. The swing to negative ORP in the last sample round may be attributed to the slightly upward gradient observed in the last sample round at PZ-5 and GEO-1.

In the last sample round the ORP measured in all nine monitoring points was negative. Based on our experience at other sites we may see a further reduction in ORP as steady state conditions are achieved in the PRW. However, we may not see ORP in the –200 to –400 mV range, because none of the monitoring points were placed directly in the PRW where we expect to see the most strongly reducing conditions.

Hydraulic Results

For the PRW to be effective groundwater must flow through the PRW. Initially, until the amendment used to inject the iron "breaks", groundwater may not flow though the wall and may tend to mound. Subsequent to the amendment "breaking" the PRW will achieve increasing permeability as the amendment "breaks" further and is degraded by naturally occurring microorganisms. Interestingly, even though the amendment has "broken" and adequate permeability is achieved, full permeability will only return slowly over time as the amendment is fully degraded.

Initial groundwater elevations measured on March 14, 2000 show an upward gradient at the PRW. Water elevations in PZ-5, the well above the PRW (screened from about 48 to 53 feet bgs), are less than the groundwater elevations in GEO-1 (screened from 70 to 80 feet, across the height of the PRW). Clearly, under pumping conditions at RW-2, these wells which are in relatively close proximity to RW-2, should have a downward gradient, given the deeper sand and gravel zone screened by GEO-1 is more permeable than the shallower zone through which PZ-5 is screened. The upward gradient at these wells suggests that at that time, the guar was still blocking flow through the PRW.

Subsequent measurement of groundwater elevations on April 21, 2000 shows no upward gradient at PZ-5 and GEO-1. At that time the gradient was downward, as it should be. In addition, the groundwater elevations show flow is through the PRW. While PZ-3 appears to be somewhat of an anomaly, we believe the field personnel may have mistaken their reading on the tape down measurement.

To further confirm groundwater flow is through the PRW groundwater elevations were re-measured on May 5, 2000, after we stopped pumping from RW-2. These measurements show groundwater flow through the PRW under a relatively flat gradient. The flat gradient may be either the result of a naturally flat hydraulic gradient and/or show some effect from residual guar in the PRW. The data shows an anomaly at PZ-4. During sampling the field technician has noted slow recharge at PZ-4. We believe PZ-4 responds very slowly to water table fluctuations. Thus, the groundwater elevations measured in PZ-4 may be inconsistent with the rest of the data set, and may not accurately reflect general groundwater elevations and flow through the PRW.

Subsequent groundwater elevation measurements show groundwater flows through the PRW with some variability in flow at the southern edge of the PRW (going from upgradient piezometer PZ-1 to downgradient piezometer PZ-4). In the last two sample rounds completed on 8/17/00 and 9/29/00 flow through the PRW at PZ-1 and PZ-4 appears reversed.

Volatile Organic Compound (VOC) Results

VOC results are shown in Figure 3. The initial levels of VOC in all the monitoring points were lower than expected. Based on historical data, PCE and TCA levels could have been as high as 400 and 600 µg/L respectively. The highest levels of PCE and TCA measured in the first two sampling rounds were in the 100 to 150 µg/L range. We believe these lower levels may not be representative of the actual groundwater concentrations of PCE and TCA prior to the injections. Due to space limitations at the site the upgradient wells were placed somewhat closer to the PRW than anticipated. As a result, they appear to have been impacted to some degree by the iron injections, as shown by the ORP results. Second, during the injections a significant volume of fluid was pumped into the ground, this would tend to flush and displace contaminated water in the vicinity of the PRW. The result is that initially we may see lower concentrations in the groundwater after the injections followed by some rebound of the VOC levels as groundwater displaces the injection amendment. The degree of rebound and when it occurs is site specific. The increasing trend in the VOC data between the first, second and third (fourth round also for GEO-1 and GEO-3) round of groundwater sampling is consistent with a rebound in VOC levels that occurred as the amendment was finally degraded.

The VOC results currently show a decreasing trend, with the exception of the above wall piezometer PZ-5. These results are consistent with the ORP data and tend to reinforce the interpretation that the early results are amendment impacted. The VOC results may also show a delayed response because the residual VOCs in the soil and groundwater around the monitoring points must be flushed before the full effect of the PRW is seen. The ORP results suggest that we have not seen the full effect of the PRW on VOC levels at the monitoring points.

Consistent with the bench scale tests the VOC results show the PRW produces no degradation byproducts such as vinyl chloride. The lack of degradation byproducts also indicates that the reductions in VOC levels are abiotic, and are the result of the reducing conditions created by the PRW.

Conclusions

Generally the ORP data show the PRW is successful. However, the data also show that the effects of the PRW were somewhat slower to develop than anticipated.

The increasingly negative trend in the ORP data (for mid-wall and downgradient wells) show the PRW is working but its effects may not be fully realized.

Groundwater elevation data show groundwater flow is through the PRW and that the guar has "broken", and degraded.

The initial levels of VOCs in the groundwater were lower than anticipated; we believe this makes sense given the iron injections appear to have impacted the monitoring points, and the injections flush and initially displace the contaminated groundwater with injection amendment. The rebound in VOC levels and subsequent decreases, in conjunction with decreasing trends in ORP is consistent with the injection amendment initially impacting the PRW effectiveness.

The VOC data show the PRW is successfully degrading VOCs. As residual VOCs undergo more flushing and the ORP becomes increasingly negative we anticipate further decreases in the levels of VOCs.

Recommendations

We make the following recommendations:

1. Continue to monitor the performance of the PRW following the pilot test work plan.

2. Re-survey PZ-1 and PZ-4 to confirm the hydraulic gradient from PZ-1 to PZ-4.

Given the ORP and VOC results we anticipate the PRW will be successful. We should be able to move forward with the full-scale design following the next round of groundwater samples.

If you have any questions about the pilot test results, please contact me at (414) 831-4115.

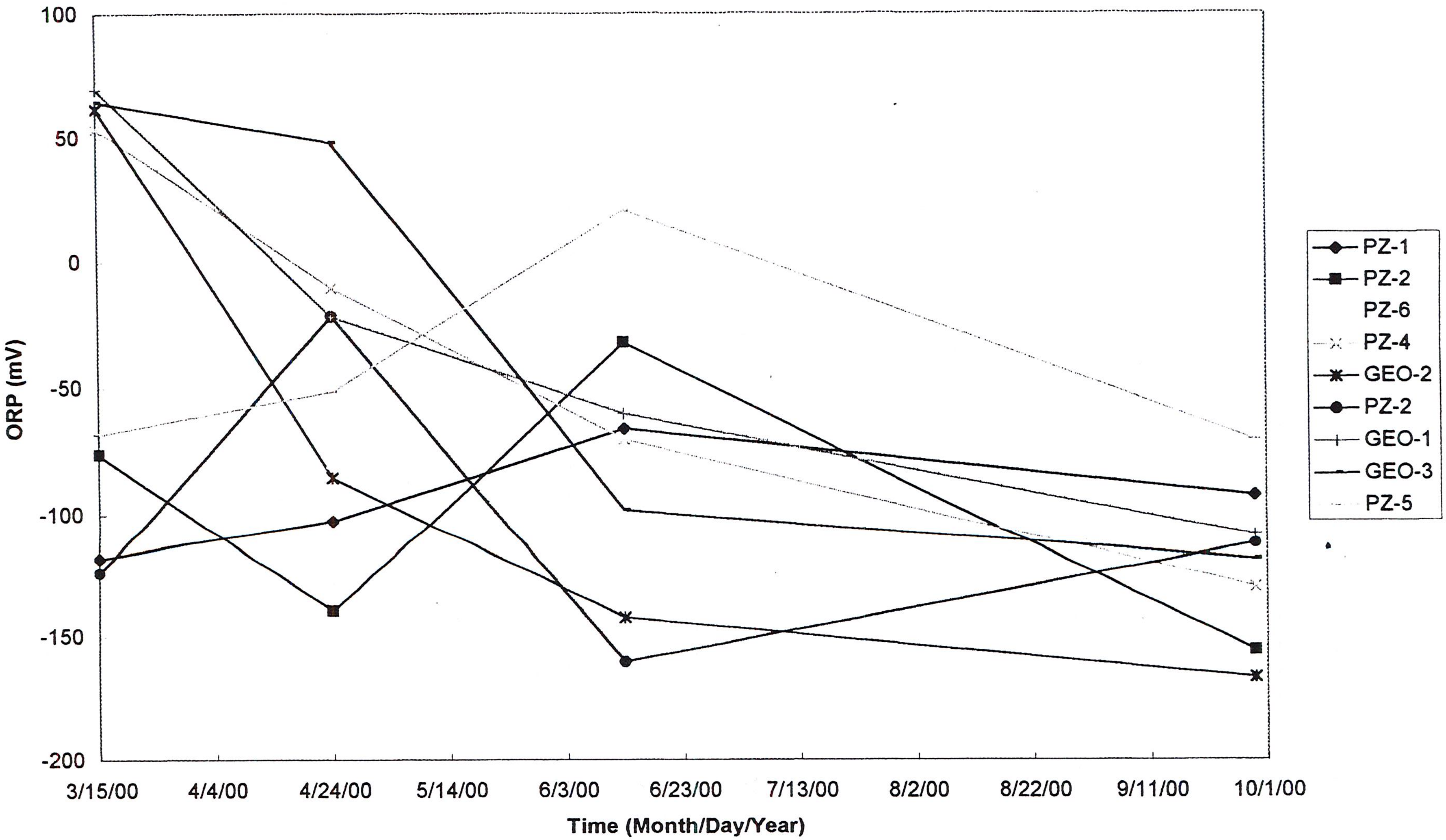
Sincerely,

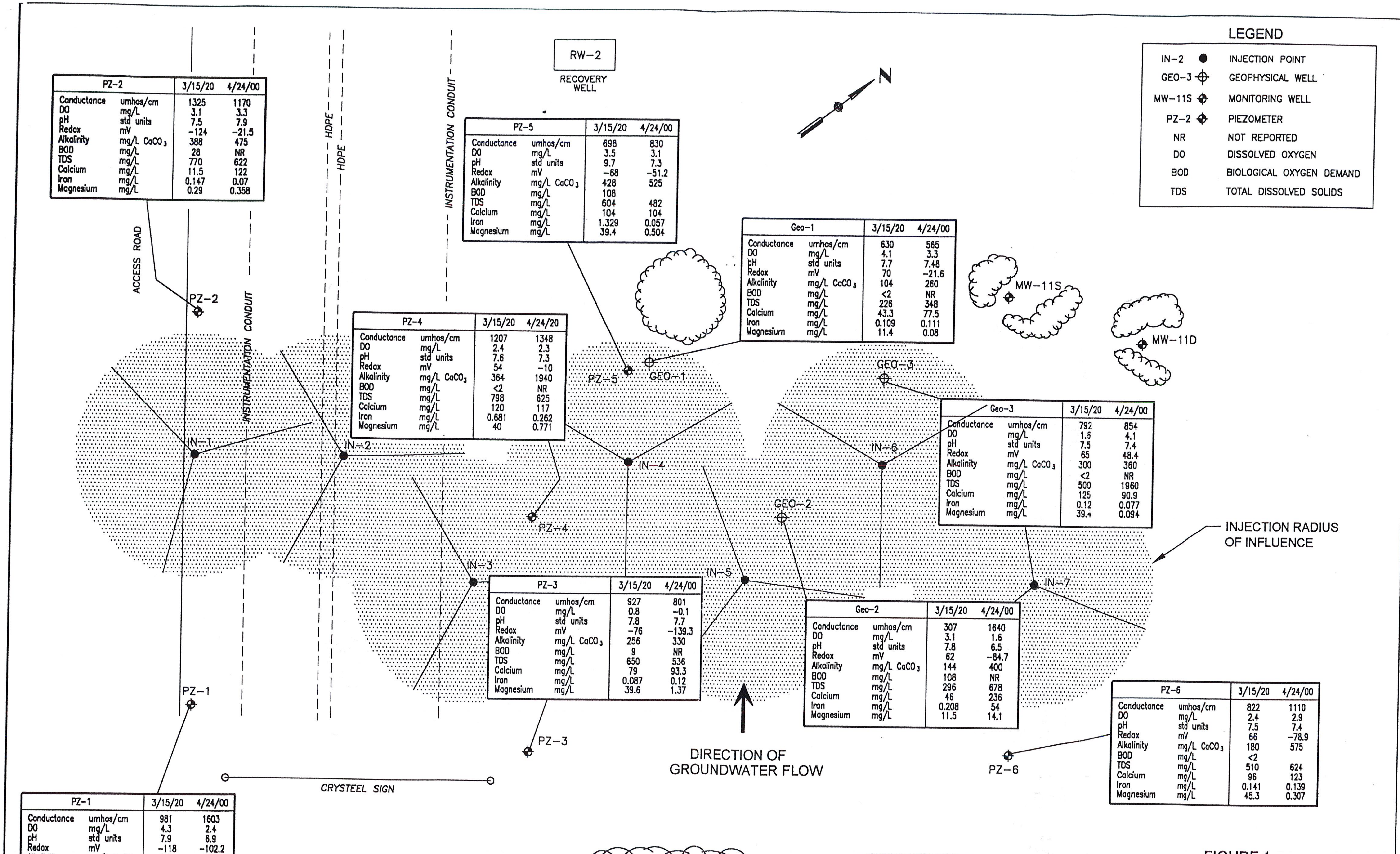
James Imbrie
Senior Engineer
URS

Table 1 - ORP Monitoring Results
Former Miller Container Plant, Fulton NY

Monitoring Point	ORP (mV)			
	3/15/2000	4/24/2000	6/13/2000	9/29/2000
Upgradient Wells				
PZ-1	-118	-102.2	-66	-92.2
PZ-3	-76	-139.3	-32	-155.5
PZ-6	66	-78.9	53	-36.9
Mid Wall Wells				
PZ-4	54	-10	-70	-129.6
GEO-2	62	-84.7	-142	-166.3
Downgradient Wells				
PZ-2	-124	-21.5	-160	-112.2
GEO-1	70	-21.6	-60	-108.2
GEO-3	65	48.4	-98	-118.5
Above Wall Wells				
PZ-5	-68	-51.2	21	-70.4

Figure 2 - ORP Trends
Former Miller Container Plant, Fulton NY





LEGEND

IN-2	●	INJECTION POINT
GEO-3	⊕	GEOPHYSICAL WELL
MW-11S	⊕	MONITORING WELL
PZ-2	⊕	PIEZOMETER
NR		NOT REPORTED
DO		DISSOLVED OXYGEN
BOD		BIOLOGICAL OXYGEN DEMAND
TDS		TOTAL DISSOLVED SOLIDS

PZ-2		3/15/20	4/24/00
Conductance	umhos/cm	1325	1170
DO	mg/L	3.1	3.3
pH	std units	7.5	7.9
Redox	mV	-124	-21.5
Alkalinity	mg/L $CaCO_3$	388	475
BOD	mg/L	28	NR
TDS	mg/L	770	622
Calcium	mg/L	11.5	122
Iron	mg/L	0.147	0.07
Magnesium	mg/L	0.29	0.358

PZ-5		3/15/20	4/24/00
Conductance	umhos/cm	698	830
DO	mg/L	3.5	3.1
pH	std units	9.7	7.3
Redox	mV	-68	-51.2
Alkalinity	mg/L $CaCO_3$	428	525
BOD	mg/L	108	
TDS	mg/L	604	482
Calcium	mg/L	104	104
Iron	mg/L	1.329	0.057
Magnesium	mg/L	39.4	0.504

Geo-1		3/15/20	4/24/00
Conductance	umhos/cm	630	565
DO	mg/L	4.1	3.3
pH	std units	7.7	7.48
Redox	mV	70	-21.6
Alkalinity	mg/L $CaCO_3$	104	260
BOD	mg/L	<2	NR
TDS	mg/L	226	348
Calcium	mg/L	43.3	77.5
Iron	mg/L	0.109	0.111
Magnesium	mg/L	11.4	0.08

PZ-4		3/15/20	4/24/20
Conductance	umhos/cm	1207	1348
DO	mg/L	2.4	2.3
pH	std units	7.6	7.3
Redox	mV	54	-10
Alkalinity	mg/L $CaCO_3$	364	1940
BOD	mg/L	<2	NR
TDS	mg/L	798	625
Calcium	mg/L	120	117
Iron	mg/L	0.681	0.262
Magnesium	mg/L	40	0.771

Geo-3		3/15/20	4/24/00
Conductance	umhos/cm	792	854
DO	mg/L	1.6	4.1
pH	std units	7.5	7.4
Redox	mV	65	48.4
Alkalinity	mg/L $CaCO_3$	300	360
BOD	mg/L	<2	NR
TDS	mg/L	500	1960
Calcium	mg/L	125	90.9
Iron	mg/L	0.12	0.077
Magnesium	mg/L	39.4	0.094

PZ-3		3/15/20	4/24/00
Conductance	umhos/cm	927	801
DO	mg/L	0.8	-0.1
pH	std units	7.8	7.7
Redox	mV	-76	-139.3
Alkalinity	mg/L $CaCO_3$	256	330
BOD	mg/L	9	NR
TDS	mg/L	650	536
Calcium	mg/L	79	93.3
Iron	mg/L	0.087	0.12
Magnesium	mg/L	39.6	1.37

Geo-2		3/15/20	4/24/00
Conductance	umhos/cm	307	1640
DO	mg/L	3.1	1.6
pH	std units	7.8	6.5
Redox	mV	62	-84.7
Alkalinity	mg/L $CaCO_3$	144	400
BOD	mg/L	108	NR
TDS	mg/L	296	678
Calcium	mg/L	46	236
Iron	mg/L	0.208	54
Magnesium	mg/L	11.5	14.1

PZ-6		3/15/20	4/24/00
Conductance	umhos/cm	822	1110
DO	mg/L	2.4	2.9
pH	std units	7.5	7.4
Redox	mV	66	-78.9
Alkalinity	mg/L $CaCO_3$	180	575
BOD	mg/L	<2	
TDS	mg/L	510	624
Calcium	mg/L	96	123
Iron	mg/L	0.141	0.139
Magnesium	mg/L	45.3	0.307

PZ-1		3/15/20	4/24/00
Conductance	umhos/cm	981	1603
DO	mg/L	4.3	2.4
pH	std units	7.9	6.9
Redox	mV	-118	-102.2
Alkalinity	mg/L $CaCO_3$	320	600
BOD	mg/L	4	NR
TDS	mg/L	632	1370
Calcium	mg/L	109	272
Iron	mg/L	0.943	0.197
Magnesium	mg/L	31.4	9.4

FIGURE 1

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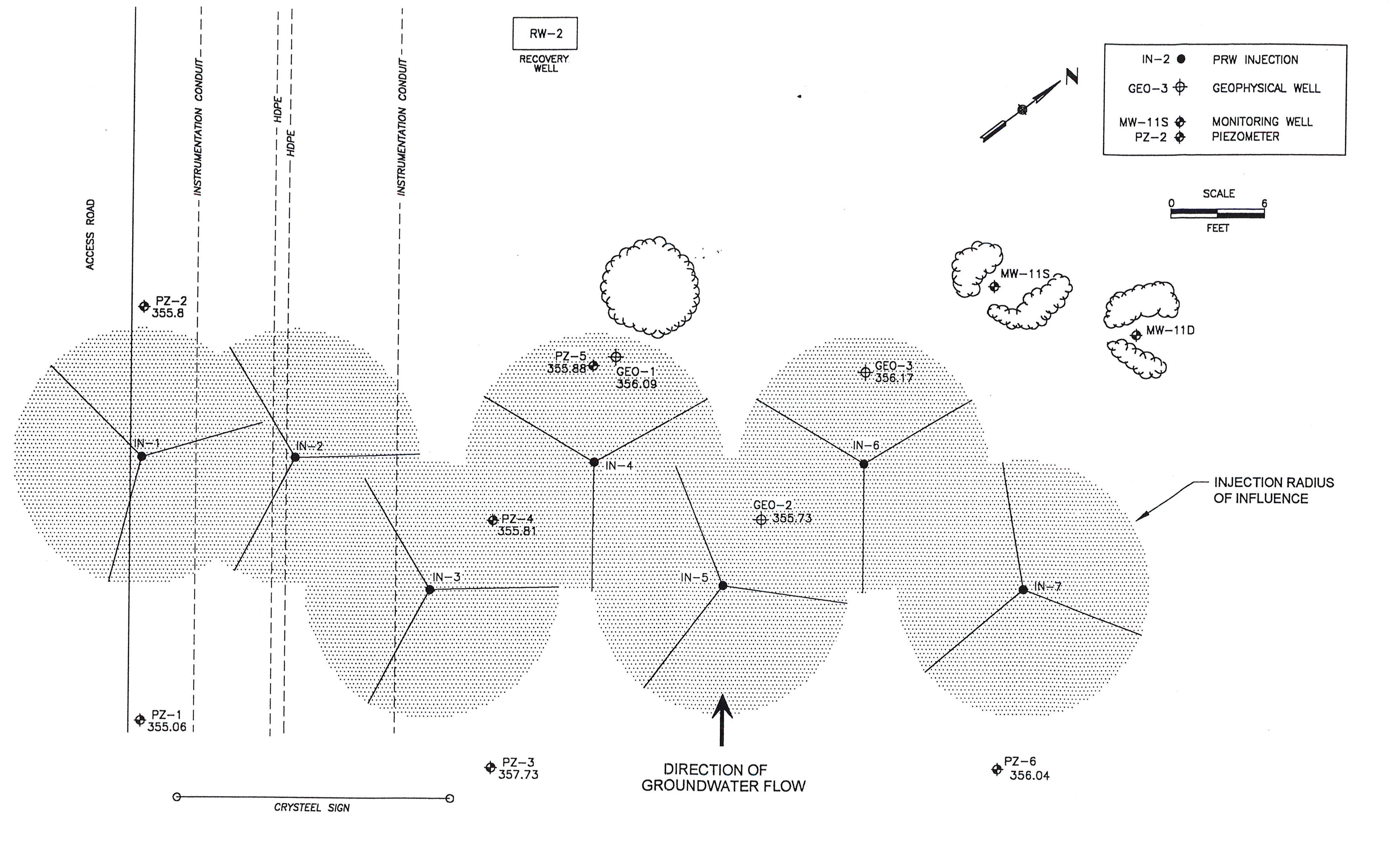

FIGURE 3

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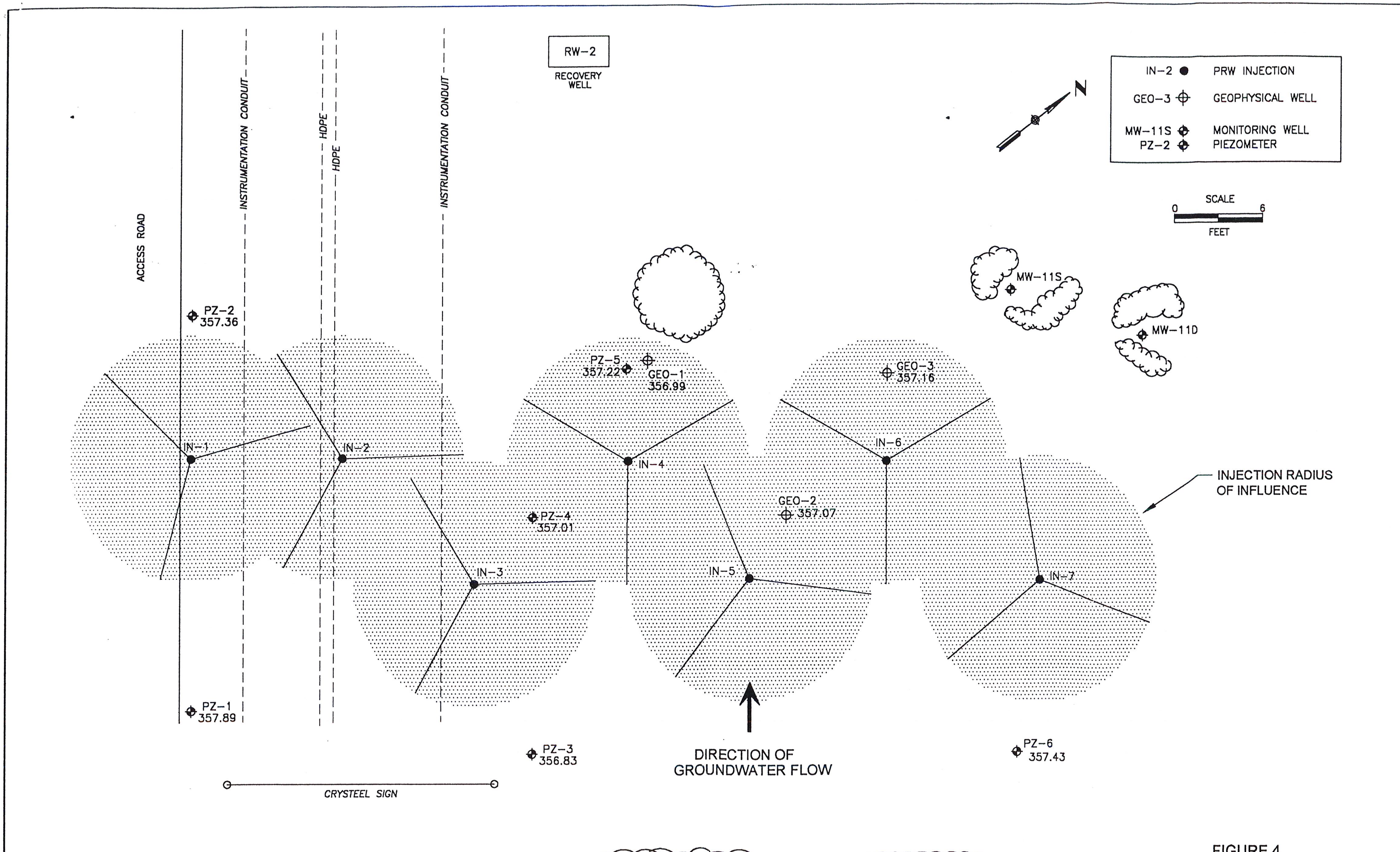

FIGURE 4

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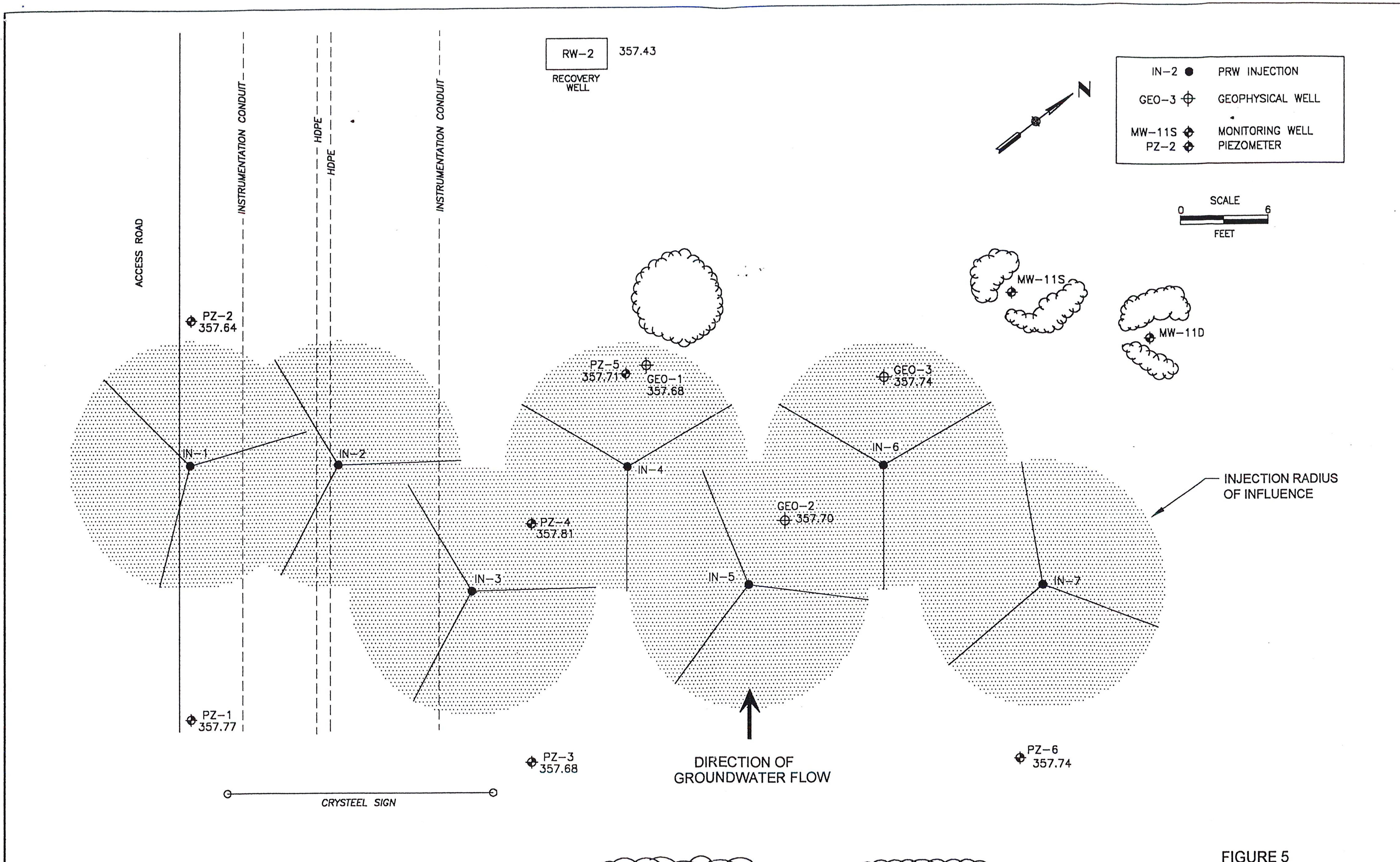

FIGURE 5

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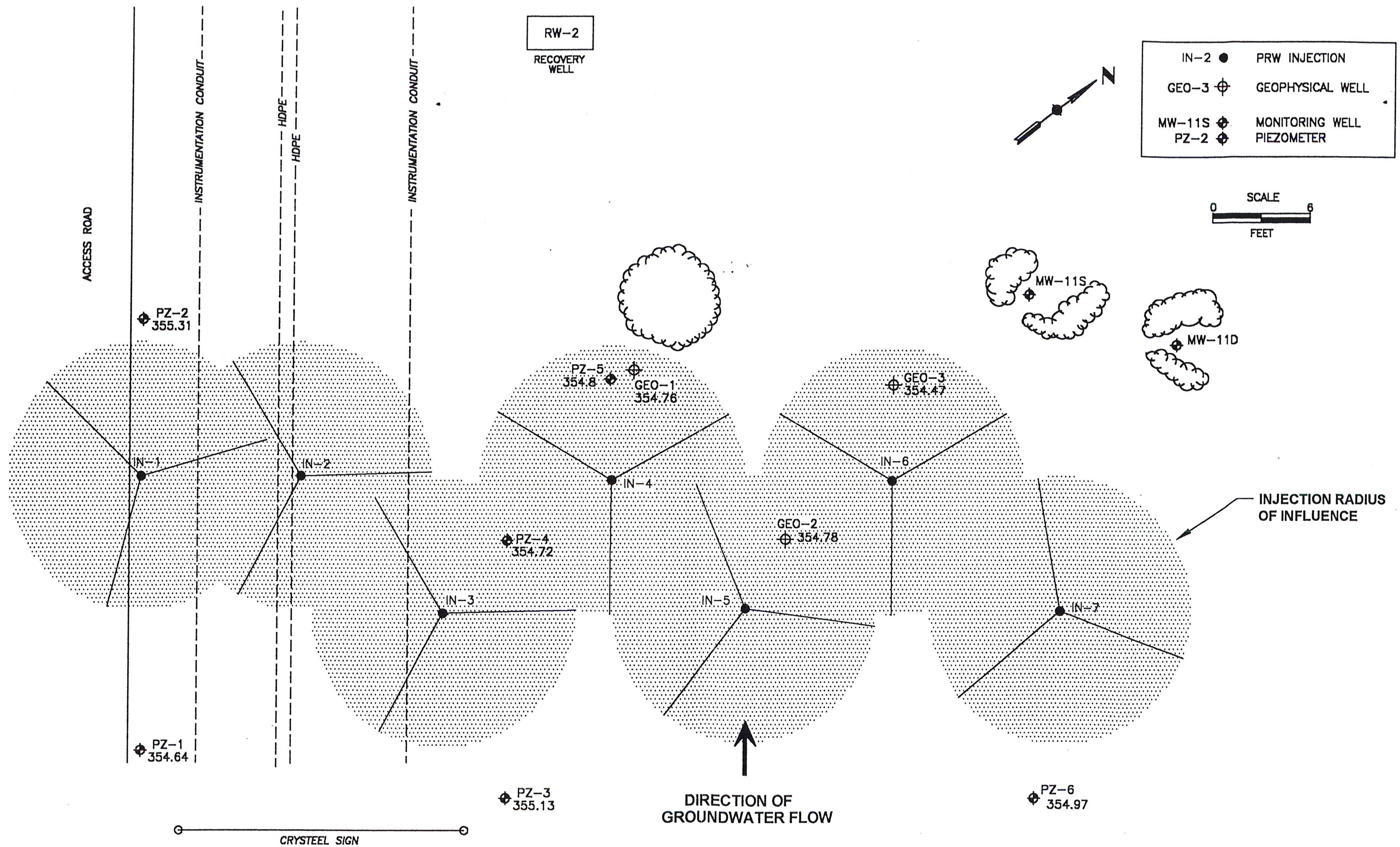

FIGURE 6

PREPARED FOR	CONFIDENTIAL–ALL RIGHTS RESERVED–PROPERTY OF URS	SCALE: AS NOTED		DRAWING TITLE: GROUNDWATER ELEVATIONS (8/18/00) MILLER BREWING CO., FULTON, NY	
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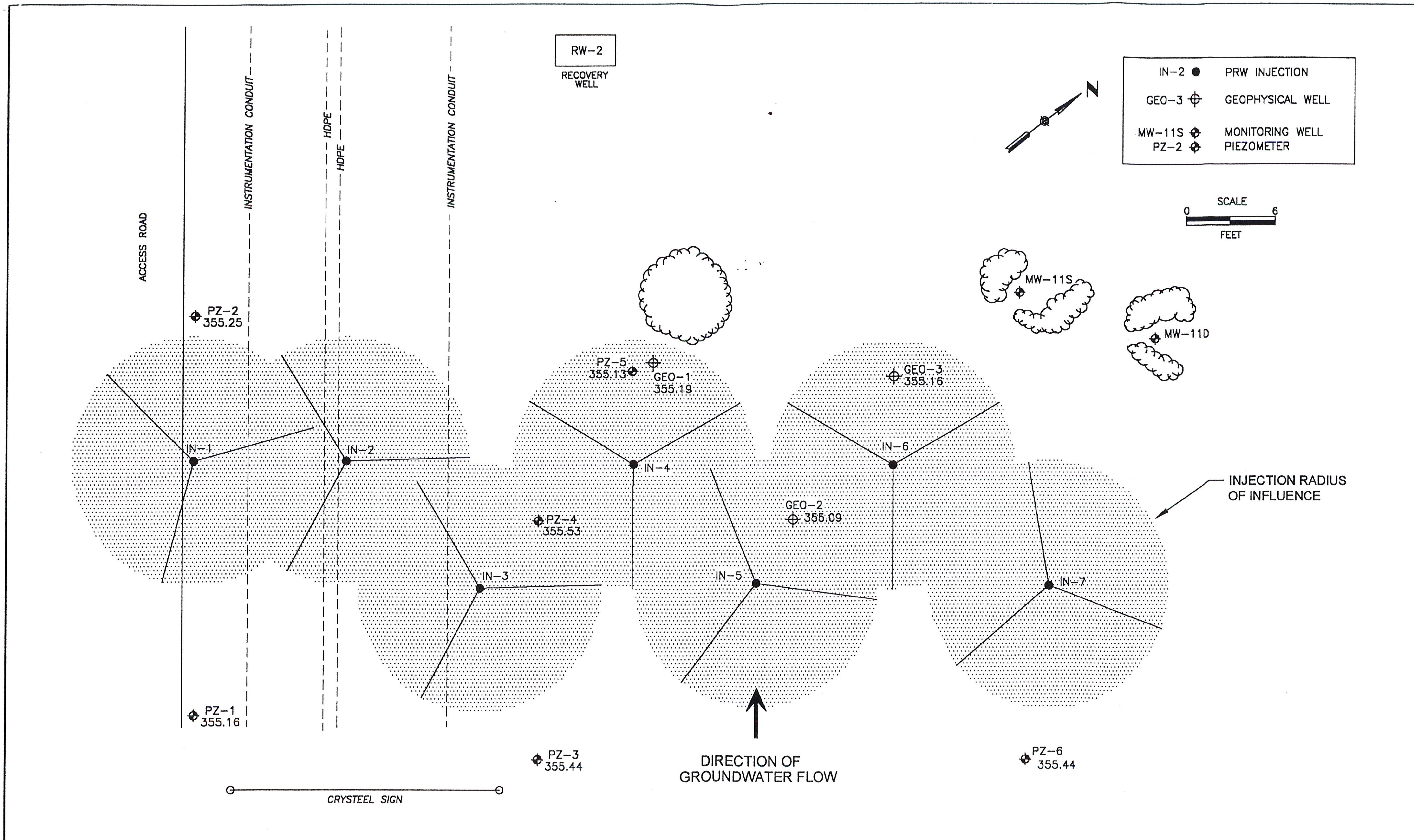

FIGURE 7

PREPARED FOR	CONFIDENTIAL–ALL RIGHTS RESERVED–PROPERTY OF URS	SCALE: AS NOTED	DRAWING TITLE: GROUNDWATER ELEVATIONS (9/29/00) MILLER BREWING CO., FULTON, NY
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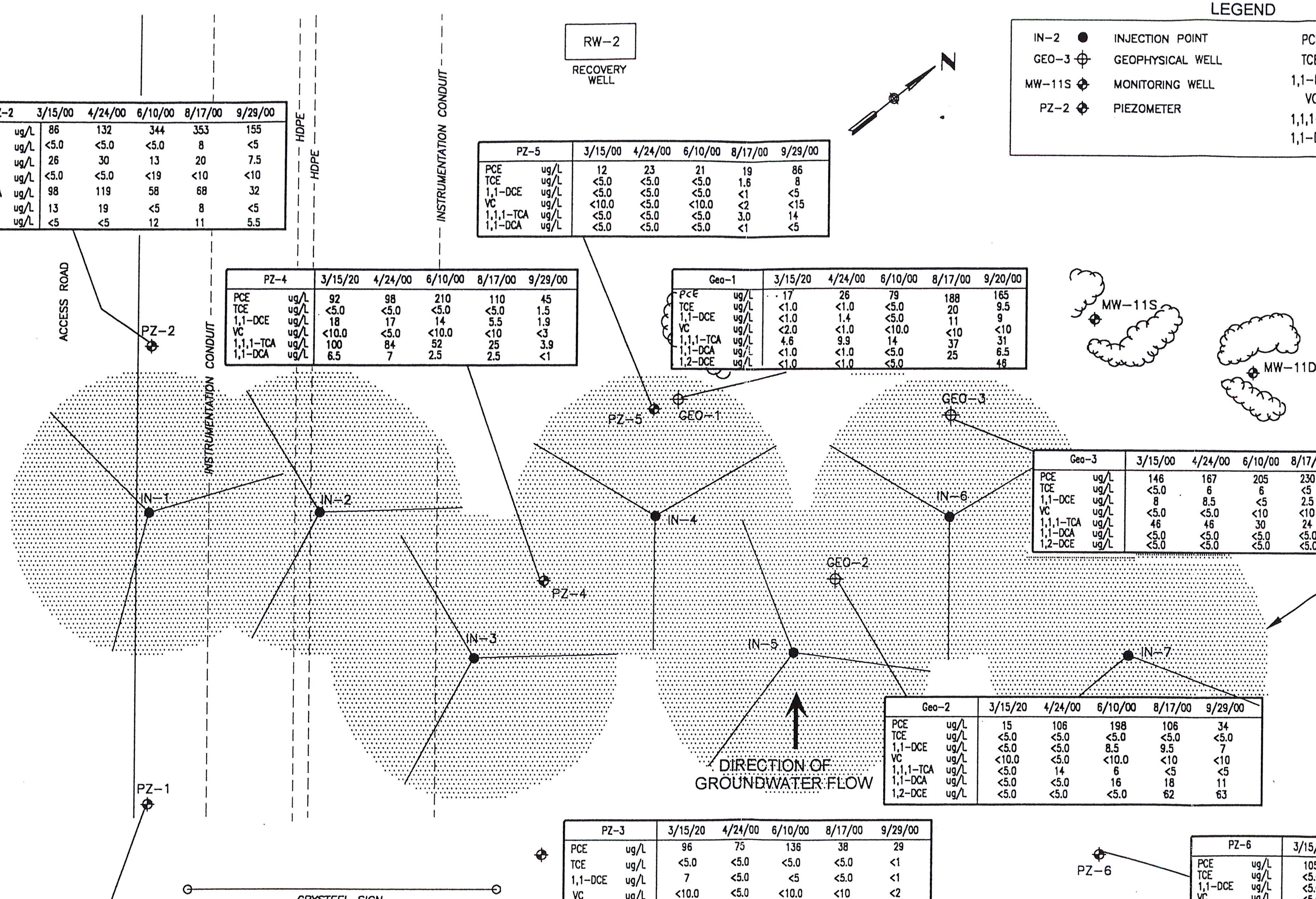

LEGEND

IN-2	INJECTION POINT	PCE	Tetrachloroethene
GEO-3	GEOPHYSICAL WELL	TCE	Trichloroethene
MW-11S	MONITORING WELL	1,1-DCE	1,1-Dichloroethene
PZ-2	PIEZOMETER	VC	Vinyl chloride
		1,1,1-TCA	1,1,1-Trichloroethane
		1,1-DCA	1,1-Dichloroethane

PZ-2		3/15/00	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	86	132	344	353	155
TCE	ug/L	<5.0	<5.0	<5.0	8	<5
1,1-DCE	ug/L	26	30	13	20	7.5
VC	ug/L	<5.0	<5.0	<19	<10	<10
1,1,1-TCA	ug/L	98	119	58	68	32
1,1-DCA	ug/L	13	19	<5	8	<5
1,2-DCE	ug/L	<5	<5	12	11	5.5

PZ-5		3/15/00	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	12	23	21	19	86
TCE	ug/L	<5.0	<5.0	<5.0	1.6	8
1,1-DCE	ug/L	<5.0	<5.0	<5.0	<1	<5
VC	ug/L	<10.0	<5.0	<10.0	<2	<15
1,1,1-TCA	ug/L	<5.0	<5.0	<5.0	3.0	14
1,1-DCA	ug/L	<5.0	<5.0	<5.0	<1	<5

PZ-4		3/15/20	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	92	98	210	110	45
TCE	ug/L	<5.0	<5.0	<5.0	<5.0	1.5
1,1-DCE	ug/L	18	17	14	5.5	1.9
VC	ug/L	<10.0	<5.0	<10.0	<10	<3
1,1,1-TCA	ug/L	100	84	52	25	3.9
1,1-DCA	ug/L	6.5	7	2.5	2.5	<1

Geo-1		3/15/20	4/24/00	6/10/00	8/17/00	9/20/00
PCE	ug/L	17	26	79	188	165
TCE	ug/L	<1.0	<1.0	<5.0	20	9.5
1,1-DCE	ug/L	<1.0	1.4	<5.0	11	9
VC	ug/L	<2.0	<1.0	<10.0	<10	<10
1,1,1-TCA	ug/L	4.6	9.9	14	37	31
1,1-DCA	ug/L	<1.0	<1.0	<5.0	25	6.5
1,2-DCE	ug/L	<1.0	<1.0	<5.0		46

Geo-3		3/15/00	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	146	167	205	230	16
TCE	ug/L	<5.0	6	6	<5	<1
1,1-DCE	ug/L	8	8.5	<5	2.5	<1
VC	ug/L	<5.0	<5.0	<10	<10	<2
1,1,1-TCA	ug/L	46	46	30	24	<1
1,1-DCA	ug/L	<5.0	<5.0	<5.0	<5.0	<1
1,2-DCE	ug/L	<5.0	<5.0	<5.0	<5.0	1.7

Geo-2		3/15/20	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	15	106	198	106	34
TCE	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-DCE	ug/L	<5.0	<5.0	8.5	9.5	7
VC	ug/L	<10.0	<5.0	<10.0	<10	<10
1,1,1-TCA	ug/L	<5.0	14	6	<5	<5
1,1-DCA	ug/L	<5.0	<5.0	16	18	11
1,2-DCE	ug/L	<5.0	<5.0	<5.0	62	63

PZ-3		3/15/20	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	96	75	136	38	29
TCE	ug/L	<5.0	<5.0	<5.0	<5.0	<1
1,1-DCE	ug/L	7	<5.0	<5	<5.0	<1
VC	ug/L	<10.0	<5.0	<10.0	<10	<2
1,1,1-TCA	ug/L	5	10	20	6	4.3
1,1-DCA	ug/L	7	<5.0	<5	<5.0	<1
1,2-DCE	ug/L	<5	<5.0	<5	6.5	3.2

PZ-6		3/15/00	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	105	150	296	160	134
TCE	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-DCE	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0
VC	ug/L	<5.0	<5.0	<10	<10.0	<10.0
1,1,1-TCA	ug/L	26	25	13	7	<5
1,1-DCA	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0

PZ-1		3/15/20	4/24/00	6/10/00	8/17/00	9/29/00
PCE	ug/L	20	58	148	6.5	8
TCE	ug/L	3.4	<5.0	<5	<5.0	<5.0
1,1-DCE	ug/L	10	<5.0	8	<5.0	<5.0
VC	ug/L	<2.0	<5.0	<10	<10	<10
1,1,1-TCA	ug/L	28	28	36	<5.0	<5.0
1,1-DCA	ug/L	13	<5.0	7	<5.0	<5.0

SCALE 0 — 6 FEET

FIGURE 8

PREPARED FOR	URS	SCALE: AS NOTED	DRAWING TITLE: GROUNDWATER VOC RESULTS MILLER BREWING CO., FULTON, NY
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