915063

CHERRY FARM/RIVER ROAD SITE
GROUNDWATER UPWELLING STUDY

June 2003 Sampling Event Data Report
Tonawanda, New York

SUBMITTED TO:

NEW YORK STATE DEPARTMENT
OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION

SUBMITTED BY:

CHERRY FARM/RIVER ROAD SITE
Potentially Responsible Parties

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October 2003

Report:

Cherry Farm/River Road Site
Groundwater Upwelling Study
June 2003 Sampling Event Data Report

Prepared For:

Cherry Farm/River Road PRP Group

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Date

October 2003

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JUNE 2003 SAMPLING EVENT DATA REPORT

INTRODUCTION

The primary objective of this groundwater upwelling study is to evaluate, through direct sampling and measurements in the Niagara River, whether the deep extraction system at the Cherry Farm/River Road Site can be permanently shut down. This report describes the methods used and presents results of the June 2003 sampling event.

- The first event was conducted prior to shutting down the extraction well system, in September 2002. The extraction system was shut-down on October 14, 2002.
- The second event was conducted in December 2002.
- The third event was conducted in March 2003.
- This fourth sampling event (third quarterly post-shutdown event) took place during the week of June 23rd, 2003.
- The fifth and final sampling event is scheduled for October 2003.

The Cherry Farm/River Road Site in Tonawanda, New York (Figure 1) currently has an 11-well groundwater extraction system that was designed to prevent migration of impacted groundwater in the deeper aquifer from reaching the Niagara River. The deeper extraction system complements a shallow groundwater trench that continues to collect groundwater in the upper aquifer. The extraction system was operated for more than five years, beginning in August 1997. Over this period, the deeper aquifer has shown historical concentrations of organic chemicals of concern typically below or near groundwater quality standards. It is expected that natural attenuation occurring between the Site and the river are reducing the observed concentrations prior to discharge to the river.

The specific goals of the field data collection are to quantify the concentrations of chemical indicators in groundwater that are potentially upwelling into the river, and to assess whether concentrations are acceptable to warrant shutdown of the deeper extraction system. The scope of work includes measuring vertical hydraulic gradients and chemical constituent concentrations in upwelling groundwater at multiple locations.

The first report (January, 2003) detailed the sampling point installation methodology and summarized the measurements and analytical data collected prior to November 27, 2002. The second and third (first and second quarterly post shut-down) reports summarized data from the December 2002 and March 2003 sampling events. The results thus far indicate no impact from the Site on groundwater beneath the river.

METHODOLOGY

The methodology for piezometer installation and groundwater sampling was detailed in the first Cherry Farm Upwelling Report (Parsons, 2002). In accordance with the work plan, the approach proposed for measuring groundwater discharge and quality into and through the river-bottom sediment is as follows:

- Measurement of hydraulic pressures (water levels) with vibrating wire piezometers.
- Initial sampling of water quality from the eight newly installed sampling stations below the river before shutting down the deep aquifer extraction system.
- Quarterly sampling of water quality from the eight sampling stations after shutting down the deep aquifer extraction system.

A summary of the sampling and analysis program from October 2002 through October 2003 is shown on Table 1. The fourth and final quarterly post shut-down sampling event is planned for October 2003.

Sampling Station Locations

Groundwater sampling pumps and vibrating wire piezometers were installed in the Niagara River sediments downgradient (west) of monitoring wells MW-4 and MW-5 (see Figure 2). Two near-shore stations, approximately 15 feet from shore and five to seven feet deep (below the sediment surface), and two offshore stations, approximately 40 feet from shore and 7 to 8 feet below the sediment surface, were constructed. These locations were chosen to characterize groundwater concentrations beneath the river, directly downgradient of the areas historically containing the highest chemical concentrations (MW-4 and MW-5).

Sampling Methods

A round of samples from the eight sampling stations and two monitoring wells (by OBG) was collected during the week of June 23, 2003. The event took place approximately eight months after shutting down the extraction wells. The samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalene, and PCBs, to determine if any of these compounds were present in groundwater below the river. The samples were also analyzed for major anions (sodium [Na], potassium [K], calcium [Ca], magnesium [Mg]) and cations (chloride [Cl], bicarbonate [HCO_3] and sulfate [SO_4]). The results were compared with an anion/cation analysis of a water sample taken directly from the river. The anion/cation comparisons were used to identify whether or not river water was drawn into the sampling pump.

The river stations were purged prior to sampling. Samples from the river stations were collected at low flow rates (less than 200 ml/ min).

Piezometer Readings

Piezometer readings, collected approximately every two weeks, were used to measure the vertical hydraulic gradient at each station. The river stage was also monitored at the same frequency using the existing staff gauge. Pressure and temperature readings were recorded from

switch boxes housed in the onsite sheds. A hand-held piezometer readout unit displayed the piezometer reading, which was recorded onto field data sheets. The data were then entered into a spreadsheet that used a linear equation to correct for changes from initial conditions and to derive hydraulic head differences. Since the distance between the piezometers in each pair was known, the vertical gradient at each river station could be calculated.

RESULTS

Major Anions and Cations

The results of the anion and cation analyses indicate a difference in water character between the river stations and river water. Thus, it appears that the river station samples are not being influenced by river water, and that leakage from the surface water to the sampling pumps does not appear to be occurring. Details of the anion/cation analyses are provided below.

Anion/cation analytical results from the June 2003 sampling event are provided in Table 2 and graphically displayed in Figure 3. Twelve analyses of major anions and cations were plotted on a Piper trilinear diagram. Eight river station (RS) water analyses and one duplicate analysis (RS-01dp-4) represented groundwater below the river. One surface water sample was collected directly from the river. A sample was collected from MW-4 and from MW-5 for representative analyses of on site groundwater.

The river surface water and monitoring well samples were moderately low in sodium and bicarbonate, and high in calcium, magnesium, chloride, and sulfate. River station samples (groundwater samples from below the river) were generally low in magnesium, calcium, chloride, and sulfate, and were high in sodium and bicarbonate.

Using the Piper diagram (Figure 3), a clear distinction can be observed between the surface water (river water) and the groundwater below the river (River Stations). The river water sample plots in the upper left side of the diamond. The river stations (RS samples) are grouped in the lower left side of the diamond.

The approximate TDS concentration also indicated a chemical differentiation between the river water and the groundwater below the river. The approximate total dissolved solids (TDS) concentration was included with cation/anion ratios on the table below the Piper diagram. The Piper bubble diagram (Figure 4) demonstrates the TDS relationship within the Piper diamond plot from Figure 3. On the figure, TDS concentration is directly related to the symbol size.

A third type of graphical presentation of cation/anion chemical analysis is the Stiff pattern (Figure 5). A polygonal shape is created from four parallel horizontal axes extending on either side of a vertical zero axis. Cations are plotted on the left side of the zero axis, and anions are plotted on the right side. The larger the area of the polygon, the greater the concentrations of the various ions (Fetter, 1994). The river water (bottom polygon) is considerably smaller than the samples of groundwater from below the river, which provides further evidence that the river stations samples (RS series) are of different chemical quality than the river water.

The anion/cation analytical results to date, from the pre-shutdown (October 2002) sampling event through the June 2003 sampling event, are provided in Figure 6. While the data show some scatter, it is becoming clearer with each additional sampling event that there is a distinction between surface water samples and groundwater samples from below the river. Similar to the results for the June 2003 event, the river water samples from previous events plot in the upper left section of the diamond, and the river stations plot in the lower left section of the diamond. The extraction well samples, collected before the system was shut down, also trend towards the upper left.

When the last round of anion and cation data are collected during the ensuing October 2003 sampling event, it will be added to the Piper trilinear plots and evaluated.

Chemical Constituents of Concern

The laboratory analytical results from the third post-shut down sampling event in June 2003 are provided in Table 2. The eight river station samples and the sample from MW-4, were below detection limits for the analyzed chemical constituents. BTEX and naphthalene were detected in the groundwater sample from MW-5.

These results indicate that chemical parameters were not impacting groundwater beneath the river at near shore locations at the time of sampling, more than eight months after shutting down the extraction wells.

Piezometer Readings

Weekly piezometer readings and river levels are summarized in Table 3. Hydraulic gradients were calculated by subtracting the shallower piezometer value from the deeper piezometer value. Positive values represent an upward hydraulic gradient, and negative values represent a downward hydraulic gradient. Hydraulic gradients ranged from -0.079 to 0.097 feet per foot (ft/ft). Piezometers were typically separated by five feet, and hydraulic head differences between the two piezometers did not exceed 0.39 feet.

Vertical hydraulic gradient measurements are graphically displayed in Figure 7 (A through D). Two adjacent stations (near shore and off shore) were plotted on each graph. For example, in Figure 7A, Station RS-1, was 15 feet from shore and Station 2 was 40 feet from shore. Odd-numbered stations are near shore (15 feet from shore) and even numbered stations are offshore (40 feet). Nearshore stations RS-1, 3, and 7 showed a consistent upward hydraulic gradient. Offshore station RS-4 showed a consistent downward gradient, and the remaining stations showed variable, but small, upward or downward gradients. In general, more consistent upward gradients were seen in the nearshore stations.

Temperatures, recorded from the river station piezometers, are shown on Table 4. The upper section of the table lists the temperature readings. The lower section of the table lists the difference between piezometers at each station. Positive values represent conditions where water adjacent to the deeper piezometer is colder than the water adjacent to the shallower piezometer; negative values represent the opposite conditions. As expected, the temperature from the

shallow piezometer in each pair was typically warmer than the deep piezometer in October 2002, as air and surface water temperatures tend to be warmer. In November 2002, the air and river temperatures cooled and the temperature differentials began to reverse. The deeper water was warmer. This trend continued through March 2003. From April to June 2003, surface water started warming, and the temperature difference between piezometers decreased. Although not an integral part of the study, temperature differentials between the deep and shallow piezometers provide further indication of groundwater upwelling, and evidence that the sand/bentonite seals are functioning appropriately.

CONCLUSIONS AND SCHEDULE

The results of the June 2003 sampling event continued to indicate no impacts from the Site on chemical concentrations in groundwater beneath the river. Results from the final sampling event conducted in October of 2003 will be evaluated and presented to the NYSDEC after the data is collected.

As shown on Table 1, the final event was conducted in October 2003. The year end report is expected to be submitted in December 2003.

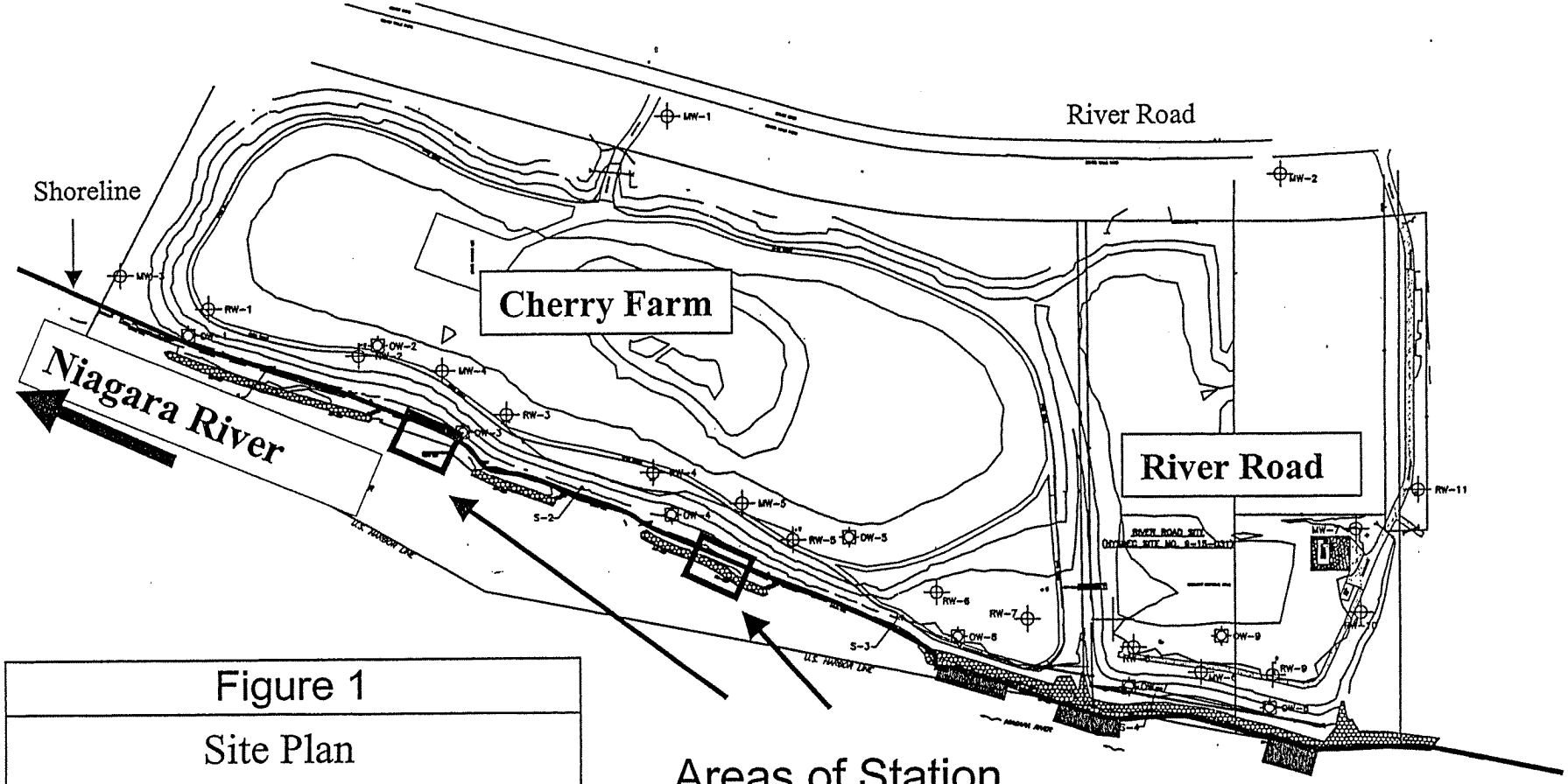

Figure 1
Site Plan
Cherry Farm/River Road Groundwater Upwelling Study
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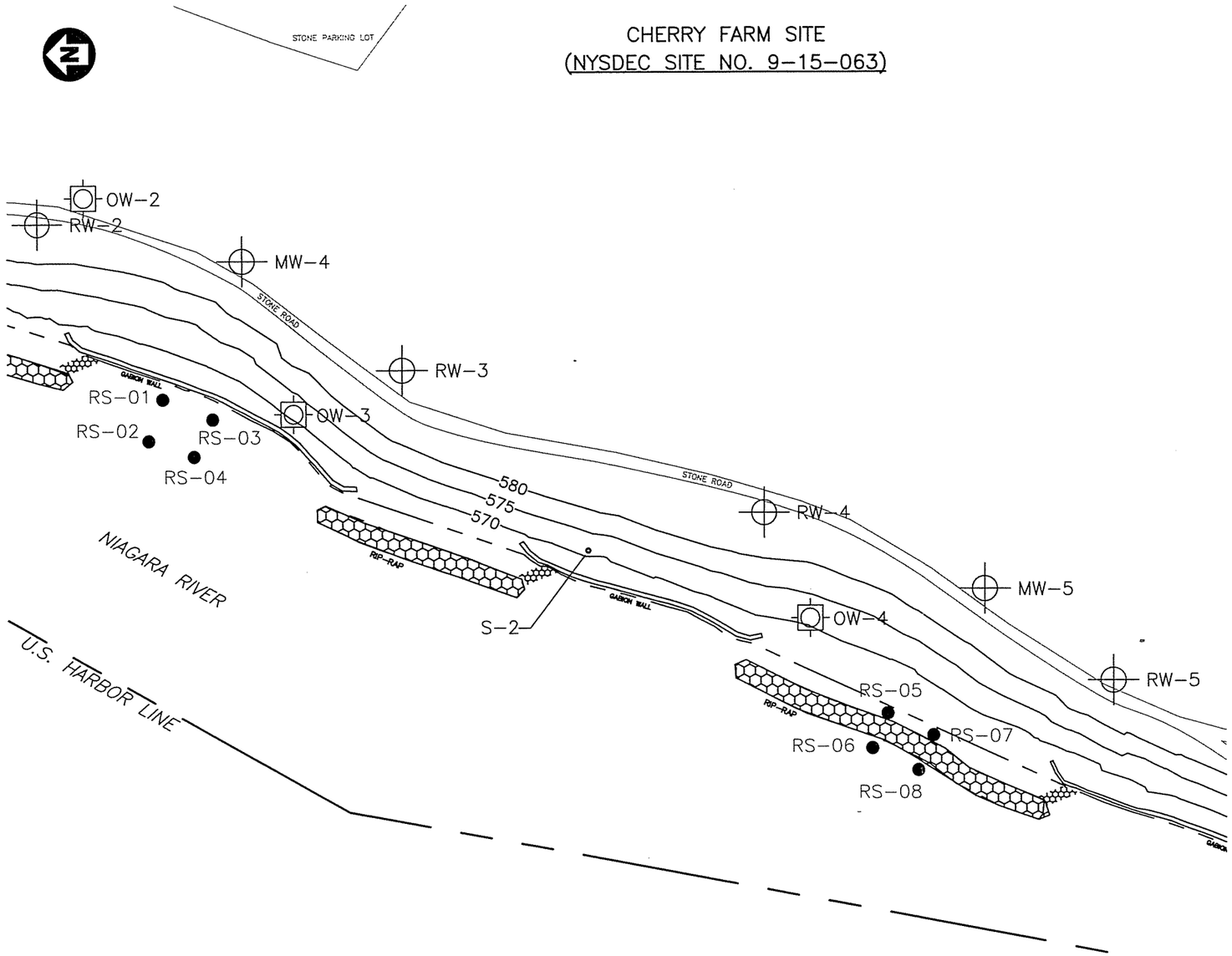
CHERRY FARM SITE
(NYSDEC SITE NO. 9-15-063)



LEGEND

● RS-04	RIVER STATION
OW-5	OBSERVATION WELL
MW-1	MONITORING WELL
RW-1	RECOVERY WELL AND VAULT
575	PROPOSED FINAL GRADE INDEX CONTOUR
	RIP-RAP

120 60 0 120 240

SCALE: 1"=120'

FIGURE 2

CHERRY FARM/RIVER ROAD SITE
ANNUAL GROUNDWATER MONITORING REPORT

SAMPLE LOCATION MAP

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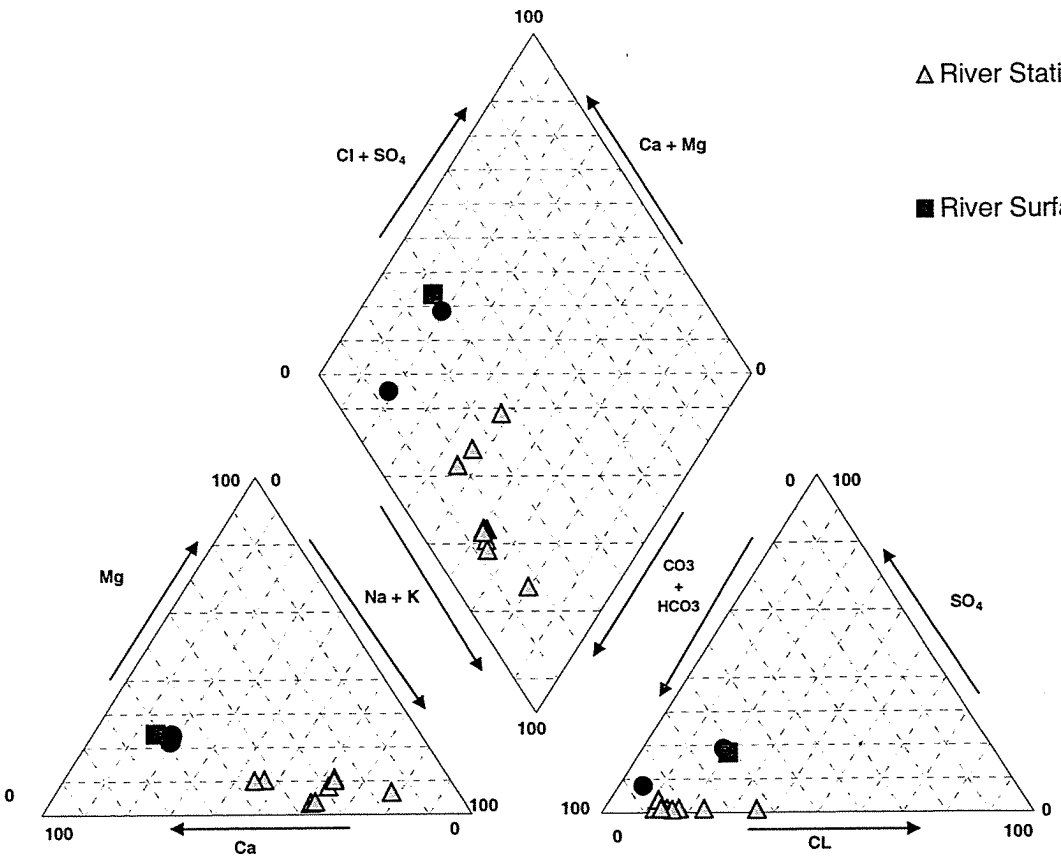

WELL	CATIONS				ANIONS				CATION-ANION	TDS (approx)
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	Cl+SO_4	HCO_3+CO_3	Balance Error	MG/L
MW-4-4	58%	24%	81%	19%	6%	8%	14%	86%	38%	745
MW-5-4	59%	22%	81%	19%	19%	19%	38%	62%	31%	889
RS-01-4	42%	10%	52%	48%	35%	1%	36%	64%	19%	1249
RS-01dp-4	43%	11%	54%	46%	23%	1%	24%	76%	45%	1133
RS-02-4	27%	10%	37%	63%	13%	2%	14%	86%	46%	1033
RS-03-4	46%	8%	55%	45%	17%	1%	19%	81%	40%	948
RS-04-4	28%	10%	38%	62%	15%	1%	16%	84%	53%	1054
RS-05-4	29%	7%	35%	65%	12%	1%	13%	87%	14%	519
RS-06-4	17%	4%	20%	80%	16%	1%	17%	83%	5%	638
RS-07-4	35%	4%	39%	61%	11%	4%	15%	85%	34%	759
RS-08-4	34%	5%	39%	61%	13%	1%	15%	85%	8%	480
RV-01-4	61%	24%	85%	15%	21%	18%	38%	62%	32%	193

Cherry Farm/River Road Site, Tonawanda, New York

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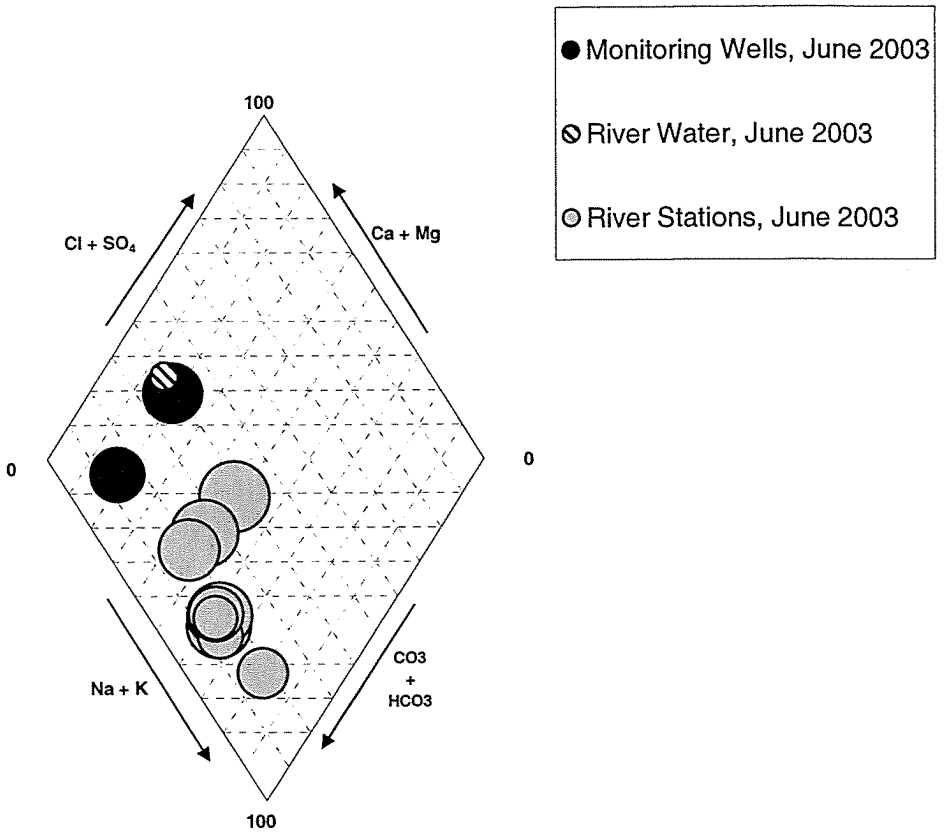
FIGURE 3
PIPER DIAGRAM
Monitoring Well, River Stations and River Water Data
June 2003 Sampling Event



WELL	CATIONS				ANIONS				CATION-ANION
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	$Cl+SO_4$	HCO_3+CO_3	Balance Error
MW-4-4	58%	24%	81%	19%	6%	8%	14%	86%	38%
MW-5-4	59%	22%	81%	19%	19%	19%	38%	62%	31%
RS-01-4	42%	10%	52%	48%	35%	1%	36%	64%	19%
RS-01dp-4	43%	11%	54%	46%	23%	1%	24%	76%	45%
RS-02-4	27%	10%	37%	63%	13%	2%	14%	86%	46%
RS-03-4	46%	8%	55%	45%	17%	1%	19%	81%	40%
RS-04-4	28%	10%	38%	62%	15%	1%	16%	84%	53%
RS-05-4	29%	7%	35%	65%	12%	1%	13%	87%	14%
RS-06-4	17%	4%	20%	80%	16%	1%	17%	83%	5%
RS-07-4	35%	4%	39%	61%	11%	4%	15%	85%	34%
RS-08-4	34%	5%	39%	61%	13%	1%	15%	85%	8%
RV-01-4	61%	24%	85%	15%	21%	18%	38%	62%	32%

Radius of Circle in diamond is proportional to TDS.

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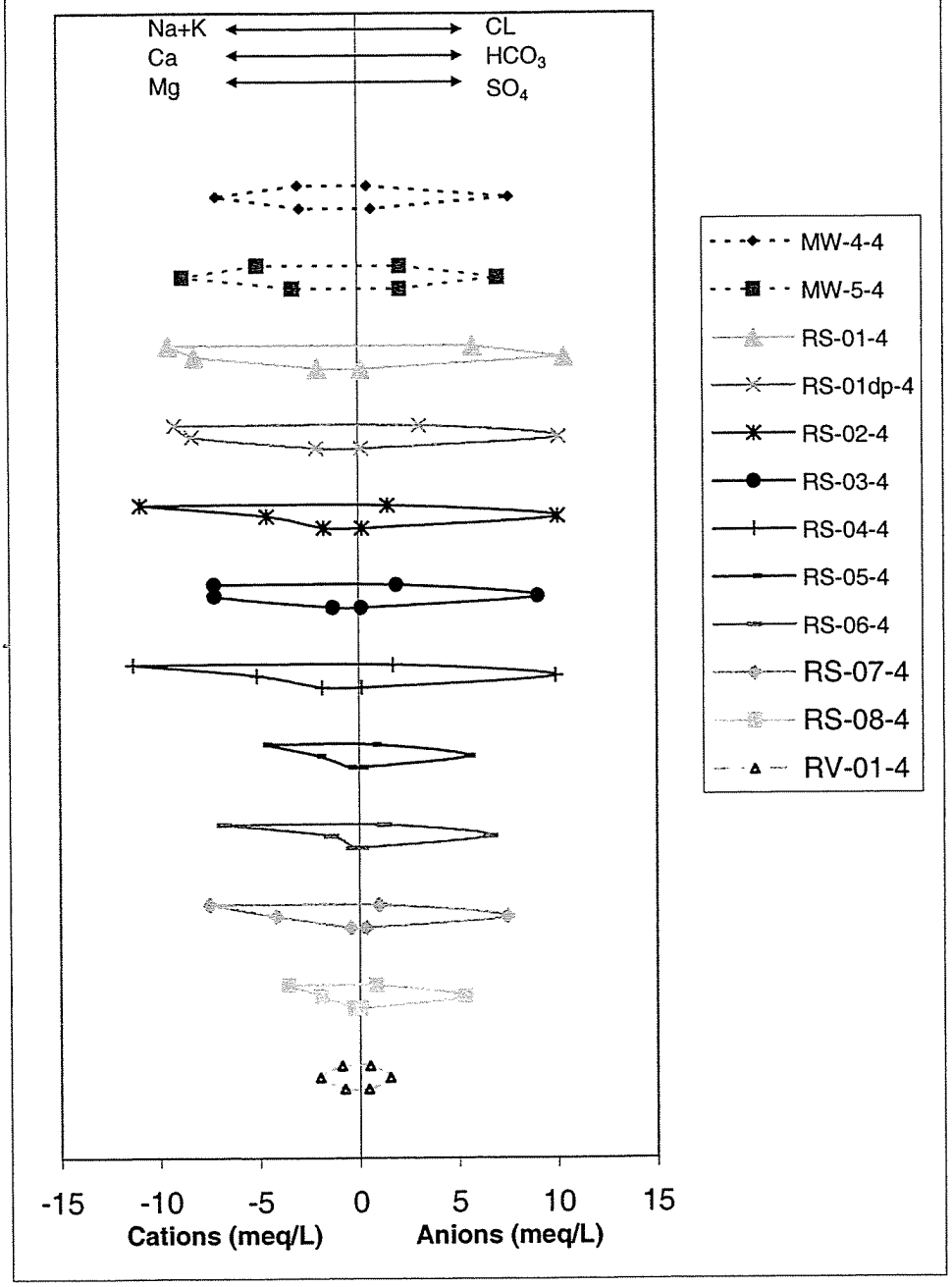
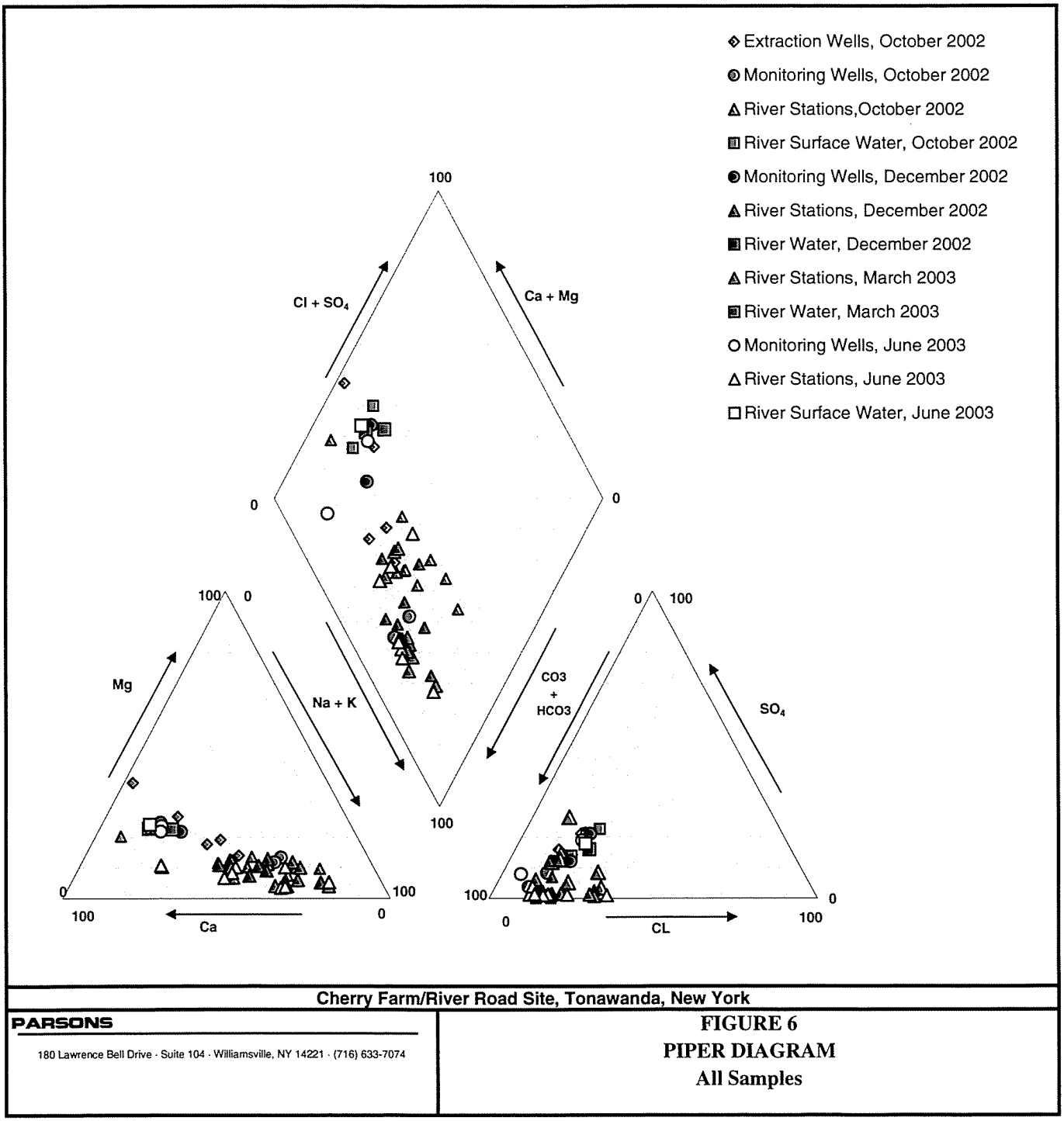
FIGURE 4
PIPER BUBBLE DIAGRAM
Monitoring Well, River Stations and River Water Data
June 2003 Sampling Event

FIGURE 5
Stiff Patterns
June 2003





Cherry Farm/River Road Site, Tonawanda, New York

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FIGURE 6
PIPER DIAGRAM
All Samples

WELL	CATIONS				ANIONS				CATION-ANION	TDS (approx)
	Ca	Mg	Ca+Mg	Na+K	Cl	SO_4	$Cl+SO_4$	HCO_3+CO_3	Balance Error	MG/L
RW-02-P	60%	38%	97%	3%	19%	21%	40%	60%	9%	899
MW-05-1	27%	13%	40%	60%	14%	8%	22%	78%	17%	589
MW-04-1	29%	12%	41%	59%	10%	4%	14%	86%	4%	881
RW-02-1	51%	27%	78%	22%	17%	21%	39%	61%	7%	1128
RW-03-1	47%	18%	65%	35%	13%	9%	22%	78%	33%	1117
RW-04-1	39%	14%	53%	47%	14%	12%	26%	74%	4%	475
RW-05-1	42%	19%	61%	39%	13%	16%	29%	71%	5%	688
RS-01-P	32%	11%	43%	57%	29%	9%	38%	62%	10%	816
RS-01-1	47%	12%	58%	42%	32%	4%	36%	64%	16%	946
RS-02-1	17%	10%	26%	74%	11%	27%	38%	62%	12%	570
RS-03-1	72%	20%	92%	8%	21%	5%	27%	73%	47%	737
RS-04-1	35%	14%	49%	51%	15%	13%	28%	72%	13%	474
RS-05-1	33%	10%	42%	58%	15%	15%	29%	71%	8%	413
RS-06-1	27%	7%	35%	65%	18%	21%	39%	61%	153%	264
RS-07-1	44%	7%	51%	49%	13%	12%	25%	75%	2%	604
RS-08-1	38%	10%	49%	51%	15%	13%	28%	72%	30%	417
RV-01-P	62%	23%	85%	15%	23%	23%	45%	55%	42%	178
RV-01-1	61%	23%	84%	16%	18%	14%	32%	68%	137%	416
MW-04-2	58%	25%	82%	18%	20%	21%	41%	59%	15%	718
MW-05-2	53%	22%	75%	25%	19%	12%	31%	69%	18%	666
RS-01-2	35%	11%	45%	55%	31%	3%	33%	67%	3%	1023
RS-02-2	25%	10%	35%	65%	15%	2%	18%	82%	13%	903
RS-03-2	47%	11%	57%	43%	21%	2%	23%	77%	6%	900
RS-04-2	31%	13%	44%	56%	16%	7%	23%	77%	0%	826
RS-05-2	33%	9%	42%	58%	13%	4%	17%	83%	12%	515
RS-06-2	18%	5%	24%	76%	19%	0%	19%	81%	1%	616
RS-07-2	29%	4%	33%	67%	12%	12%	25%	75%	14%	733
RS-08-2	39%	7%	47%	53%	14%	0%	14%	86%	52%	539
RV-01-2	60%	23%	83%	17%	23%	16%	39%	61%	29%	211
RS-01-3	43%	12%	55%	45%	27%	1%	28%	72%	8%	1073
RS-01dp-3	42%	12%	54%	46%	28%	1%	30%	70%	2%	1045
RS-02-3	24%	12%	36%	64%	14%	2%	15%	85%	5%	933
RS-03-3	43%	10%	54%	46%	20%	1%	21%	79%	2%	876
RS-04-3	22%	10%	32%	68%	15%	1%	16%	84%	7%	956
RS-05-3	25%	6%	31%	69%	12%	1%	13%	87%	7%	528
RS-06-3	17%	4%	21%	79%	18%	1%	19%	81%	28%	601
RS-07-3	33%	4%	37%	63%	12%	6%	18%	82%	6%	691
RS-08-3	30%	5%	35%	65%	14%	1%	16%	84%	40%	470
RV-01-3	55%	23%	78%	22%	27%	18%	45%	55%	10%	159
MW-4-4	58%	24%	81%	19%	6%	8%	14%	86%	38%	745
MW-5-4	59%	22%	81%	19%	19%	19%	38%	62%	31%	889
RS-01-4	42%	10%	52%	48%	35%	1%	36%	64%	19%	1249
RS-01dp-4	43%	11%	54%	46%	23%	1%	24%	76%	45%	1133
RS-02-4	27%	10%	37%	63%	13%	2%	14%	86%	46%	1033
RS-03-4	46%	8%	55%	45%	17%	1%	19%	81%	40%	948
RS-04-4	28%	10%	38%	62%	15%	1%	16%	84%	53%	1054
RS-05-4	29%	7%	35%	65%	12%	1%	13%	87%	14%	519
RS-06-4	17%	4%	20%	80%	16%	1%	17%	83%	5%	638
RS-07-4	35%	4%	39%	61%	11%	4%	15%	85%	34%	759
RS-08-4	34%	5%	39%	61%	13%	1%	15%	85%	8%	480
RV-01-4	61%	24%	85%	15%	21%	18%	38%	62%	32%	193

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FIGURE 6 (continued)
PIPER DIAGRAM
All Samples

FIGURE 7A
Vertical Hydraulic Gradients
Stations RS-1 and RS-2

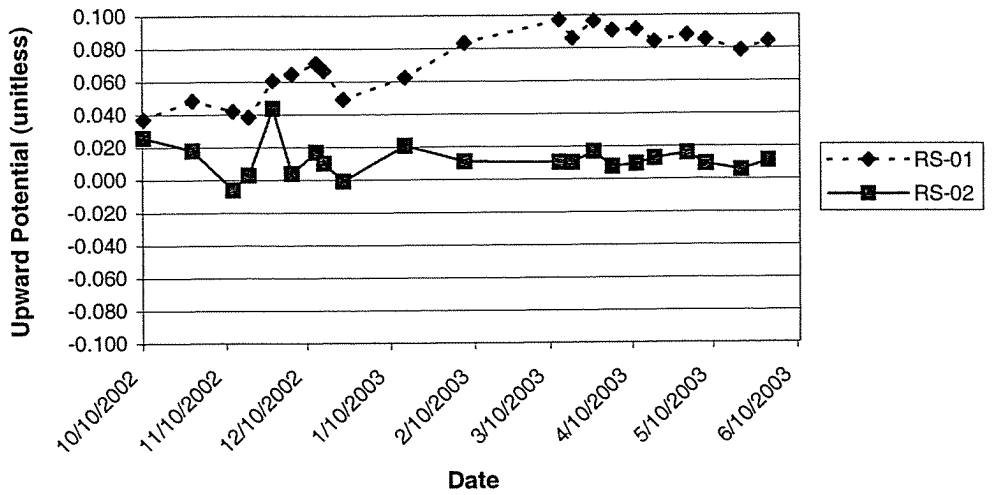

FIGURE 7B
Vertical Hydraulic Gradients
Stations RS-3 and RS-4

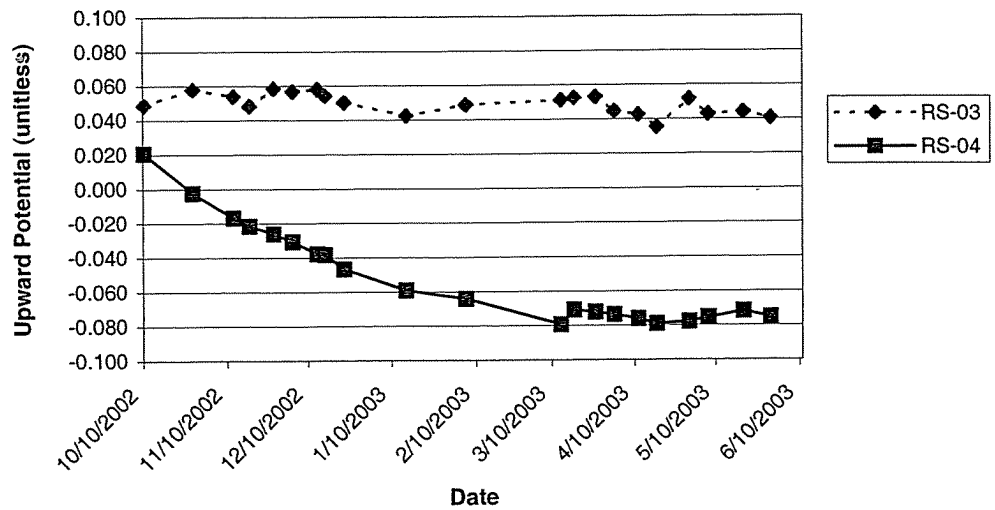

FIGURE 7 (A and B)
Vertical Hydraulic Gradients
October 2002 through April 2003

FIGURE 7C
Vertical Hydraulic Gradients
Stations RS-5 and RS-6

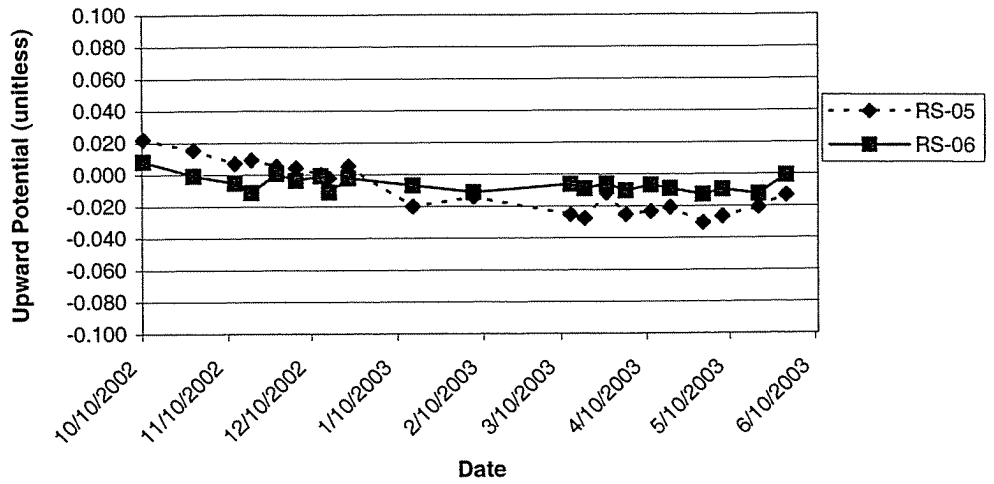

FIGURE 7D
Vertical Hydraulic Gradients
Stations RS-7 and RS-8

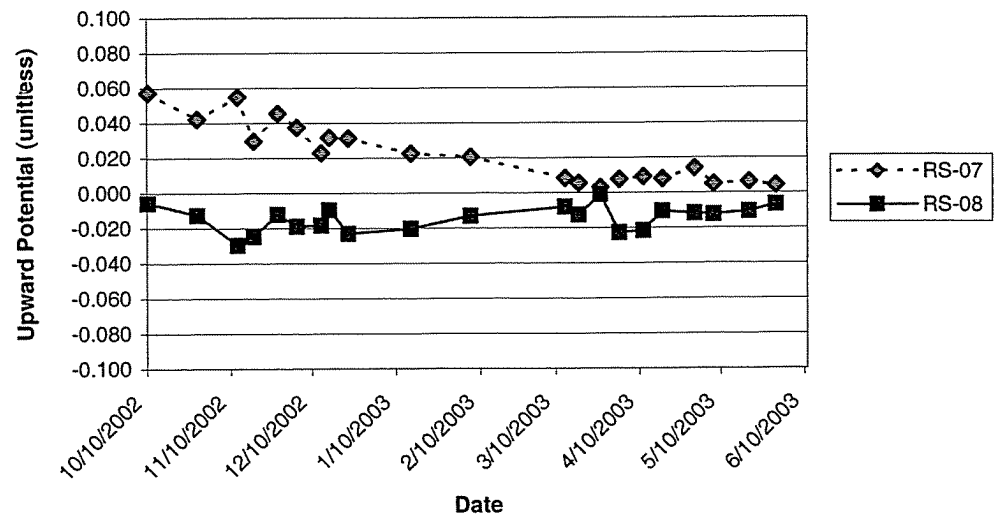

FIGURE 7 (C and D)
Vertical Hydraulic Gradients
October 2002 through April 2003

Table 1

Cherry Farm/River Road Groundwater Upwelling Study
Sampling and Analysis Summary (Revised from Initial Report- Table 1)

Sampling Events						
Event	Date	BTEX	naphthalene	PCBs	cat/anion*	Comments
Pre-shutdown	Sept and Oct. 02	15	15	15	15	9 RSs, 5RWs, 2MWs, 1 dupe, 2 riv. Sample for cat/anions (no cat/anion dupe).
Quarter 1	Dec. 02	11	11	11	12	8 RSs, 2MWs, 1 dupe, MWs done by OBG, one riv. Samp. For cat/anions.
Quarter 2	Mar. 03	9	9	9	9	8 RSs, 1 dupe, one riv. sample for cat/ions, no cat/anion dupe.
Quarter 3	June 03	11	11	11	12	Same as Dec. 02
Quarter 4	Oct. 03	15	15	15	15	Same as Oct. 02
Total		**61**	**61**	**61**	**63**	

*Ca, Na, Mg, bicarbonate, Cl, Sulfate
MWs: MW-4, MW-5
RWs: RW-2, RW-3, RW-4, and RW-5

Samples will go to CES, with the exception of MW-4 and MW-5 samples in Dec. 02 and June 03, which are done by OBG.

Table 2
Laboratory Analytical Results

Cherry Farm Upwelling Data Study June 2003		Sample ID: Lab Sample Id Depth: Source: SDG: Matrix: Sampled: Validated:	MW-4 327478/A7432 CES/OBG 11246-3/5716 WATER 6/24/2003	MW-5 327475/A7431 CES/OBG 11246-3/5716 WATER 6/24/2003	RS-01 327428 CES 11246-3 WATER 6/23/2003	RS-02 327438 CES 11246-3 WATER 6/23/2003	RS-03 327443 CES 11246-3 WATER 6/23/2003	RS-04 327448 CES 11246-3 WATER 6/23/2003	RS-05 327453 CES 11246-3 WATER 6/23/2003	RS-06 327458 CES 11246-3 WATER 6/24/2003	RS-07 327463 CES 11246-3 WATER 6/24/2003	RS-08 327468 CES 11246-3 WATER 6/24/2003	RS-10 327433 CES 11246-3 WATER 6/23/2003	RV-01 327473 CES 11246-3 WATER 6/23/2003	TRIP BLANK 327477 CES 11246-3 WATER 6/24/2003
CAS NO.	COMPOUND	UNITS:													
	VOLATILES														
71-43-2	Benzene	ug/L	10 U	38	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U		0.7 U
108-88-3	Toluene	ug/L	10 U	4 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U
100-41-4	Ethylbenzene	ug/L	10 U	2 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U
1330-20-7	Total Xylenes	ug/L	10 U	7 J	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U	3 U		3 U
	SEMIVOLATILES														
91-20-3	Naphthalene	ug/L	10 U	5 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U		
	PCBs														
11104-28-2	Aroclor 1221	ug/L	2 U	2 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11141-16-5	Aroclor 1232	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
53469-21-9/12	Aroclor 1242/1016	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
12672-29-6	Aroclor 1248	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11097-69-1	Aroclor 1254	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
11096-82-5	Aroclor 1260	ug/L	1 U	1 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U	0.065 U		
	METALS														
7440-70-2	Calcium, Total	mg/L	141	175	163	91.6	144	102	41.1	28.3	83.6	38.8	166	40.1	
7439-95-4	Magnesium, Total	mg/L	35	39.5	24.6	21.1	15.8	22.5	5.88	3.59	5.57	3.7	25.5	9.58	
7440-23-5	Sodium, Total	mg/L	52.2	65.5	214	247	162	256	107	153	164	80.6	207	11.1	
	OTHER														
	Bicarbonate Alkalinity	mg/L	465	430	634	613	551	605	335	404	454	324	617	93.1	
(CHLOR)	Chloride	mg/L	18	76	205	52	68	61	26	45	35	29	110	18	
(SULFA)	Sulfate	mg/L	33.9	103	7.96	8.79	7.11	7.64	4 U	4 U	16.7	4 U	7.75	21.2	

Note: OBG analyzed VOCs, SVOCs, and PBCs for MW-04 and MW-05. CES analyzed metals and other parameters for MW-04 and MW-05.

TABLE 3
Vertical Hydraulic Gradients

Station ID		10/10/02	10/28/02	11/12/02	11/18/02	11/27/02	12/4/02	12/13/02	12/16/02	12/23/02	1/15/03	2/6/03	3/13/03	3/18/03	3/26/03	4/2/03	4/11/03	4/18/03	4/30/03	5/7/03	5/20/03	5/30/03
RS-01	Head difference between pair (ft)	0.15	0.19	0.17	0.15	0.24	0.26	0.28	0.27	0.20	0.25	0.33	0.39	0.34	0.39	0.36	0.37	0.34	0.35	0.34	0.31	0.34
	Upward Hydraulic Gradient	0.037	0.049	0.042	0.038	0.061	0.065	0.071	0.067	0.049	0.062	0.083	0.097	0.086	0.096	0.091	0.092	0.084	0.088	0.085	0.079	0.084
RS-02	Head difference between pair (ft)	0.10	0.07	-0.02	0.01	0.17	0.02	0.07	0.04	0.00	0.08	0.04	0.04	0.04	0.07	0.03	0.04	0.05	0.06	0.04	0.02	0.04
	Upward Hydraulic Gradient	0.026	0.018	-0.006	0.003	0.044	0.004	0.017	0.010	-0.001	0.021	0.011	0.011	0.010	0.017	0.008	0.010	0.013	0.016	0.009	0.006	0.011
RS-03	Head difference between pair (ft)	0.17	0.20	0.19	0.17	0.20	0.20	0.20	0.19	0.18	0.15	0.17	0.18	0.18	0.19	0.16	0.15	0.12	0.18	0.15	0.15	0.14
	Upward Hydraulic Gradient	0.049	0.058	0.054	0.048	0.058	0.057	0.058	0.054	0.050	0.042	0.049	0.051	0.052	0.053	0.045	0.043	0.035	0.052	0.043	0.044	0.041
RS-04	Head difference between pair (ft)	0.11	-0.01	-0.09	-0.12	-0.14	-0.17	-0.21	-0.21	-0.26	-0.33	-0.35	-0.44	-0.39	-0.40	-0.41	-0.42	-0.43	-0.43	-0.41	-0.39	-0.41
	Upward Hydraulic Gradient	0.021	-0.003	-0.017	-0.022	-0.026	-0.031	-0.038	-0.038	-0.047	-0.059	-0.064	-0.079	-0.071	-0.072	-0.074	-0.076	-0.079	-0.078	-0.075	-0.072	-0.075
RS-05	Head difference between pair (ft)	0.08	0.05	0.03	0.03	0.02	0.01	0.00	-0.01	0.02	-0.07	-0.05	-0.09	-0.10	-0.04	-0.09	-0.08	-0.07	-0.11	-0.09	-0.07	-0.05
	Upward Hydraulic Gradient	0.022	0.016	0.007	0.009	0.005	0.004	0.000	-0.002	0.005	-0.020	-0.014	-0.025	-0.028	-0.012	-0.025	-0.023	-0.021	-0.030	-0.026	-0.021	-0.013
RS-06	Head difference between pair (ft)	0.03	0.00	-0.02	-0.04	0.00	-0.01	0.00	-0.04	-0.01	-0.02	-0.04	-0.02	-0.03	-0.02	-0.04	-0.02	-0.03	-0.05	-0.03	-0.04	0.00
	Upward Hydraulic Gradient	0.008	-0.001	-0.005	-0.011	0.001	-0.004	-0.001	-0.011	-0.002	-0.007	-0.011	-0.006	-0.009	-0.006	-0.010	-0.007	-0.009	-0.013	-0.010	-0.012	-0.001
RS-07	Head difference between pair (ft)	0.23	0.17	0.22	0.12	0.18	0.15	0.09	0.13	0.13	0.09	0.08	0.03	0.02	0.01	0.03	0.04	0.03	0.06	0.02	0.02	0.02
	Upward Hydraulic Gradient	0.057	0.042	0.055	0.030	0.045	0.037	0.023	0.032	0.031	0.023	0.020	0.008	0.006	0.003	0.008	0.009	0.008	0.014	0.005	0.006	0.004
RS-08	Head difference between pair (ft)	-0.02	-0.04	-0.10	-0.09	-0.04	-0.07	-0.06	-0.03	-0.08	-0.07	-0.05	-0.03	-0.04	0.00	-0.08	-0.08	-0.04	-0.04	-0.04	-0.04	-0.02
	Upward Hydraulic Gradient	-0.006	-0.013	-0.030	-0.025	-0.012	-0.019	-0.018	-0.010	-0.023	-0.020	-0.013	-0.008	-0.013	-0.001	-0.023	-0.022	-0.011	-0.012	-0.012	-0.011	-0.007
River Level	(ft at staff gauge)	0.4	NS	NS	0.4	-0.5	NS	-0.80	-0.40	0.7	ICE	ICE	ICE	NS	0.0	-0.20	0.15	0.1	0.0	0.2	0.3	0.2

NS: No measurement

TABLE 4
PIEZOMETER TEMPERATURE SUMMARY

Station ID	Piezometer ID	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F
		10-Oct-02	28-Oct-02	12-Nov-02	18-Nov-02	27-Nov-02	4-Dec-02	13-Dec-02	16-Dec-02	23-Dec-02	15-Jan-03	6-Feb-03
RS-01D	2351	60.3	59.9	58.6	57.9	57.1	56.2	55.0	54.4	53.4	50.9	49.2
RS-01S	2352	64.6	61.3	57.5	56.3	53.9	52.6	50.2	49.5	48.2	45.1	43.0
RS-02D	2353	67.8	57.9	57.6	57.5	57.0	56.7	56.0	55.7	55.4	53.4	52.1
RS-02S	2354	66.0	60.7	59.1	58.4	57.1	56.2	55.0	54.4	53.4	50.7	48.9
RS-03D	2355	63.8	59.7	58.4	57.8	56.7	55.9	54.4	54.1	53.1	50.4	48.5
RS-03S	2356	67.0	61.3	57.8	56.8	54.6	53.1	51.2	50.4	49.2	46.0	43.9
RS-04D	2358	64.9	57.1	56.8	56.7	56.2	55.9	55.2	55.0	54.4	52.8	51.7
RS-04S	2357	64.9	61.9	59.4	58.4	57.0	55.9	54.2	53.6	52.5	49.6	47.5
RS-05D	2359	57.5	57.5	57.1	56.8	56.2	55.9	55.0	54.4	54.1	52.1	50.9
RS-05S	2360	61.0	60.0	58.3	57.5	56.0	55.2	53.6	52.6	52.0	49.2	47.5
RS-06D	2361	59.5	58.9	58.3	57.9	57.1	56.7	56.7	54.7	56.7	53.7	52.6
RS-06S	2362	61.4	60.3	58.6	57.6	56.5	56.5	54.1	53.1	52.5	49.8	47.9
RS-07D	2363	56.5	56.8	56.7	56.5	56.0	55.5	55.0	54.6	54.2	52.5	51.3
RS-07S	2364	60.3	59.4	57.8	57.1	55.9	55.0	53.7	52.9	52.3	49.6	47.9
RS-08D	2366	59.5	56.8	58.3	56.8	56.0	56.7	56.7	54.7	56.7	53.7	52.6
RS-08S	2365	60.5	59.7	58.4	57.8	56.8	55.7	54.6	53.9	53.3	50.9	49.5
River water		63.32	53.42	50	46.76	40.3			33.9	36	32	32
River in swale						39.7				37	32	32

Station ID		Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F
RS-01		-4.3	-1.4	1.1	1.6	3.2	3.6	4.8	4.9	5.2	5.8	6.2
RS-02		1.8	-2.8	-1.5	-0.9	-0.1	0.5	1.0	1.3	2.0	2.7	3.2
RS-03		-3.2	-1.6	0.6	1.0	2.1	2.8	3.2	3.7	3.9	4.4	4.6
RS-04		0.0	-4.8	-2.6	-1.7	-0.8	0.0	1.0	1.4	1.9	3.2	4.2
RS-05		-3.5	-2.5	-1.2	-0.7	0.2	0.7	1.4	1.8	2.1	2.9	3.4
RS-06		-1.9	-1.4	-0.3	0.3	0.6	0.2	2.6	1.6	4.2	3.9	4.7
RS-07		-3.8	-2.6	-1.1	-0.6	0.1	0.5	1.3	1.7	1.9	2.9	3.4
RS-08		-1.0	-2.9	-0.1	-1.0	-0.8	1.0	2.1	0.8	3.4	2.8	3.1

Blank Cell: No measurement

TABLE 4
PIEZOMETER TEMPERATURE SUMMARY

Station ID	Piezometer ID	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F	Temperature °F
		12-Mar-03	18-Mar-03	26-Mar-03	3-Apr-03	11-Apr-03	18-Apr-03	30-Apr-03	7-May-03	20-May-03	30-May-03
RS-01D	2351	46.1	45.7	45.2	45.1	44.8	44.8	44.8	44.9	45.5	46
RS-01S	2352	40.2	40.1	40.1	40.5	40.4	40.8	42.4	43.4	44.9	46.3
RS-02D	2353	49.5	49.2	48.7	48.4	47.9	47.8	47.3	47.3	47.2	47.3
RS-02S	2354	45.8	45.5	45.1	44.8	44.6	44.3	44.6	44.8	45.5	46
RS-03D	2355	45.7	45.2	44.8	44.6	44.3	44.2	44.3	44.6	45.1	45.7
RS-03S	2356	41.0	40.8	40.8	41.1	41.0	41.3	42.7	43.6	45.1	46.1
RS-04D	2358	49.0	48.5	48.2	47.8	47.5	47.2	46.9	46.7	46.6	46.1
RS-04S	2357	44.5	44.0	43.7	43.7	43.7	43.4	44.0	44.5	45.4	46.1
RS-05D	2359	48.2	47.8	47.3	47.2	46.7	46.6	46.3	46.3	46.3	46.7
RS-05S	2360	44.3	44.3	43.9	43.7	43.6	43.4	43.7	44	44.9	45.7
RS-06D	2361	50.6	49.8	49.8	49.2	48.7	48.9	48.1	47.6	47.9	49.9
RS-06S	2362	45.2	44.9	44.6	44.5	44.3	44.2	44.3	44.5	45.4	46
RS-07D	2363	48.9	48.4	48.1	47.8	47.5	47.2	46.9	46.7	46.7	46.9
RS-07S	2364	45.1	44.8	44.5	44.3	44.0	43.9	43.9	44.3	44.9	45.7
RS-08D	2366	51.3	51.0	50.7	50.4	49.9	49.8	49.5	49.2	49.3	49.2
RS-08S	2365	46.7	46.4	46.0	46.0	45.7	45.5	45.4	45.5	46	46.4
River water		32	33.26	36.86	37.76	43.7	37.58	47.12	46	50	
River in swale		32			41.36	41					
Station ID		Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F	Difference °F
RS-01		5.9	5.6	5.1	4.6	4.4	4.0	2.4	1.5	0.6	-0.3
RS-02		3.7	3.7	3.6	3.6	3.3	3.5	2.7	2.5	1.7	1.3
RS-03		4.7	4.4	4.0	3.5	3.3	2.9	1.6	1.0	0.0	-0.4
RS-04		4.5	4.5	4.5	4.1	3.8	3.8	2.9	2.2	1.2	0.0
RS-05		3.9	3.5	3.4	3.5	3.1	3.2	2.6	2.3	1.4	1.0
RS-06		5.4	4.9	5.2	4.7	4.4	4.7	3.8	3.1	2.5	3.9
RS-07		3.8	3.6	3.6	3.5	3.5	3.3	3.0	2.4	1.8	1.2
RS-08		4.6	4.6	4.7	4.4	4.2	4.3	4.1	3.7	3.3	2.8

Blank Cell: No measuremer