Conceptual Design Report pH Level Control and Greensand Filter Study

Contract No. W912EE-06-D-0021
Task Order No. 0006

U.S. Army Corps of Engineers
Vicksburg District
Vicksburg, Mississippi
Cold Regions Research & Engineering Laboratory
Hanover, New Hampshire

Final
April 2009

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A Stanley Group Company
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Introduction

Study Purpose

This study addresses two concerns of the trichloroethylene (TCE) treatment system and the noncontact cooling water (NCCW) systems at the Corps of Engineers Cold Regions Research and Environmental Laboratory (CRREL) in Hanford, New Hampshire:

1. Violation of the National Pollutant Discharge Elimination System (NPDES) Permit for pH limits, and
2. Inadequate performance of the greensand filters (GSF).

The causes for the high pH levels in the noncontact cooling water discharge to the river are discussed in this study. The existing carbon dioxide system used for pH control is evaluated. Alternatives for pH control are presented.

The existing GSF remove iron from well water prior to air stripping. This reduces the fouling potential in the air strippers and downstream NCCW systems. CRREL has experienced operational problems with the filters. This study addresses how the performance of the GSF can be improved. Alternative iron removal methods are also presented.

Objectives of Facilities

The objectives of CRREL's TCE treatment system and NCCW systems should be considered when evaluating the alternatives presented in this report.

The primary objectives of these two systems are:

1. TCE Removal - Remove TCE from the groundwater such that the NPDES limit of 5 micrograms per liter is achieved.

2. NCCW Supply - Provide a reliable water supply for noncontact cooling water in the various lab facilities and also for building cooling.
3. NPDES Conformance - Meet the requirements of the NPDES Permit. This report focuses on the pH requirement of this permit.

The secondary objectives of these two systems are:

1. Cost Minimization - Minimize costs to run the two systems. Capital, maintenance and operational costs need to be taken into consideration.
2. Operation Ease - Provide a system that is easy to operate.

Description of Existing Facilities

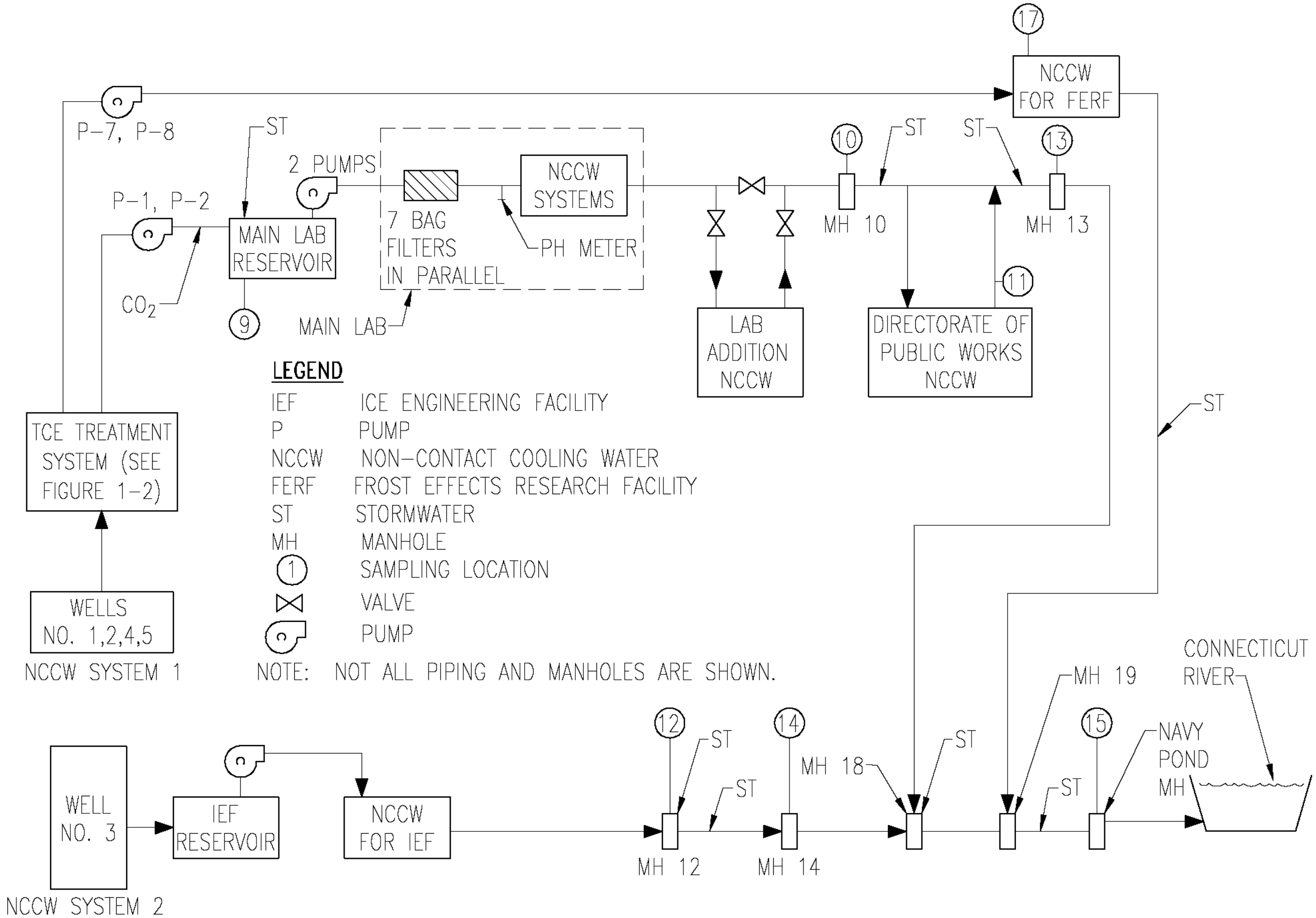
A schematic of the NCCW systems at CRREL is shown in Figure 1-1. Five production wells at CRREL are used for NCCW. The NCCW is used in the various cold research laboratories and for general building air conditioning systems. There are two separate NCCW systems. One system uses four wells and the second system uses only Well No. 3. The discharge flows from these two systems flow into two separate combined stormwater/NCCW sewer systems. These two sewer systems combine at a manhole upstream of the Navy Pond Manhole. (Navy Pond refers to an abandoned research pond.)

Tables 1-1 and 1-2 and Appendix A provide existing equipment data. Section 3 presents more information on the carbon dioxide feed system. Section 4 presents more information on the greensand filters.

NCCW System 1

Water from four wells (Wells No. 1, 2, 4, and 5) is treated for TCE removal. Usually only 2 or 3 wells are used at any given time. The TCE treatment system (see Figure 1-2) includes pretreatment with potassium permanganate and greensand filters for iron and manganese removal followed by two air stripping towers in series to remove TCE. Carbon dioxide is added to Reservoir No. 1, Reservoir No. 2, and to the discharge line from the High Lift Pumps, P-1 and P-2, to reduce calcium carbonate precipitation and lower the pH. The High Lift Pumps discharge at a reservoir near the Main Lab. One or two pumps at this reservoir supply water to the NCCW systems in the Main Lab. Downstream of the Main Lab Reservoir Pumps are seven bag filters and an inline pH meter. The bag filters used in the Main Lab are Stainrite Model SP50P-C2ST, 50 micron. The cartridges are 7.3 inches long and 31 inches in diameter. All seven bags are changed weekly.

Some of the NCCW from the discharge line from the Main Lab can be diverted to the Lab Addition Building for NCCW in that building. The combined flow from the Main Lab and Lab Addition buildings discharges into an open sewer system, which also collects stormwater. Downstream, water is diverted from the sewer for NCCW purposes in the Logistics Facility and the Directorate of Public Works Building (PW). All this water eventually discharges into a combined stormwater/NCCW discharge line which discharges into the Connecticut River near the “Navy Pond”.



Schematic of NCCW Systems

Figure 1-1

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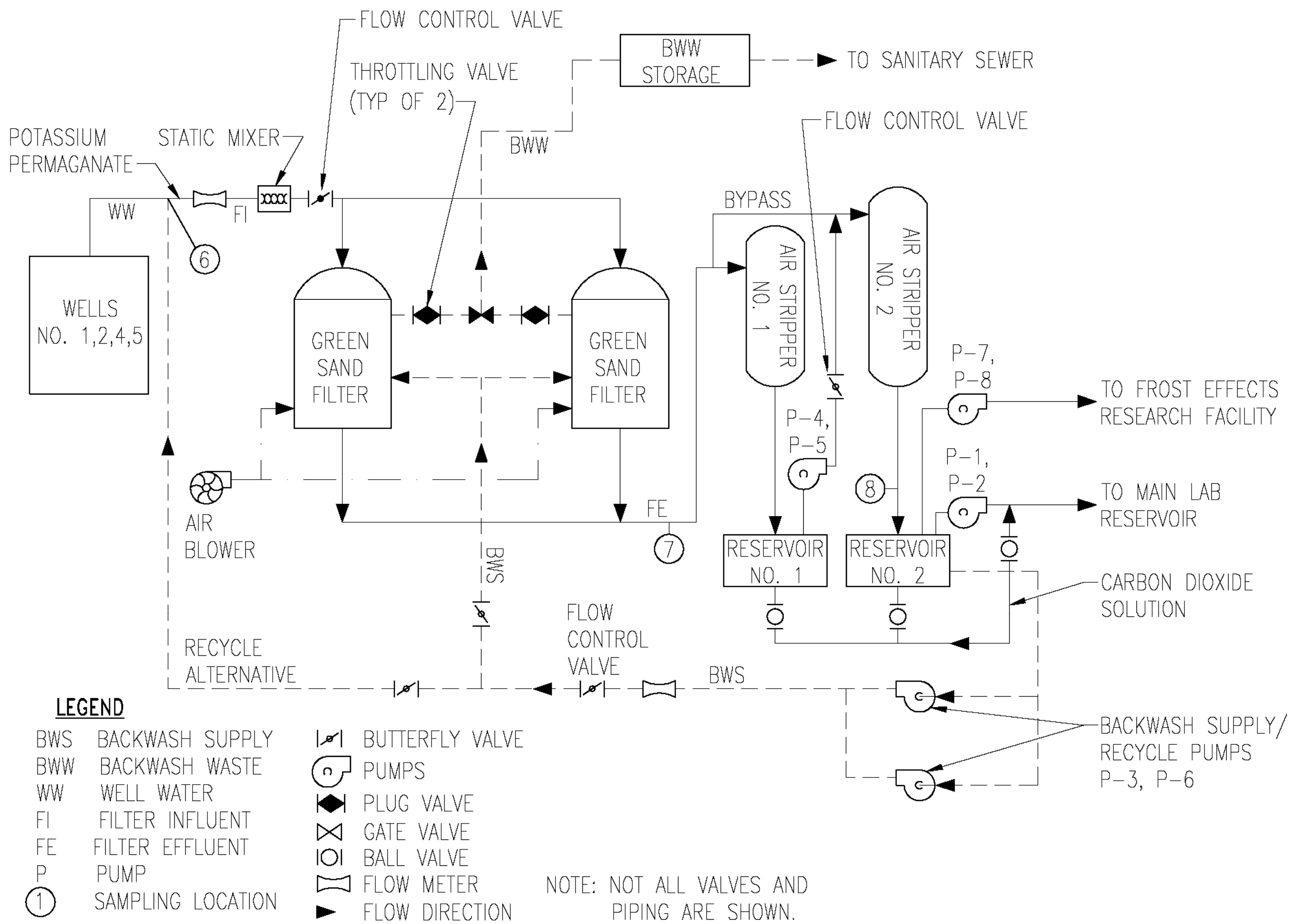

Schematic of CRREL TCE Treatment System

Figure 1-2

Table 1-1 Information on Existing TCE Facility Equipment

TCE PLANT

Unit #	Item	Manufacturer	Model	Serial	Specifications	Location
TP-P-1	Pump, High Lift	Ingersoll-Dresser	G73965	93-70-101067-1	10 HP 500 gpm	Outside
TP-P-2	Pump, High Lift	Ingersoll-Dresser	G73965	93-70-101067-2	10 HP 500 gpm	Outside
TP-P-3	Pump, Backwash	Ingersoll-Dresser	G73964	93-70-101068-1	25 HP 935 gpm	Outside
TP-P-4	Pump, Low Lift	Ingersoll-Dresser	G73968	93-70-101065-1	15 HP 800 gpm	Outside
TP-P-5	Pump, Low Lift	Ingersoll-Dresser	G73968	93-70-101065-2	15 HP 800 gpm	Outside
TP-P-6	Pump, Backwash	Ingersoll-Dresser	G73964	93-70-101068-2	25 HP 935 gpm	Outside
TP-P-7	Pump, FERF	Ingersoll-Dresser	8M23-8	93-70-101066-1	15 HP 200 gpm	Outside
TP-P-8	Pump, FERF	Ingersoll-Dresser	8M23-8	93-70-101066-2	15 HP 200 gpm	Outside
TP-AB-3	Air Blower	Universal Blower	GACLDLA	M87873	For Backwash	Process Area
TP-CP-3	Circulating Pump	Bell & Gossett	B608S40	172741	1 1/2 x 5 1/4	Mechanical Room
TP-CA-1	Carbon Adsorbers	Hydrogroup	2896 86	GAC 1443 2 FRP	7728 CFM	Process Area, East
TP-CA-2	Carbon Adsorbers	Hydrogroup	2896 86	GAC 1443 1 FRP	7728 CFM	Process Area, West
TP-GSF-A	Green Sand Filter	Monarch Water Systems	BUC-W Series	22743		Process Area
TP-GSF-B	Green Sand Filter	Monarch Water Systems	BUC-W Series	22744		Process Area
TP-SP-1	Sump Pump	Vanton Pump	SG-V300G	18013	40 gpm	Process Area
TP-MP-1	Metering Pump	Pulsa Feeder Inc	680-H-S-E	9350051-1	6 gph	Process Area
TP-MP-2	Metering Pump	Pulsa Feeder Inc	680-H-S-E	9350051-2	6 gph	Process Area
TP-ST-1	Stripping Tower	Hydrogroup	2896-86		850 gpm	Outside
TP-ST-2	Stripping Tower	Hydrogroup	2896-86		850 gpm	Outside
TP-HC-1	Heating Coil	Berdell Industries	092292-08		20 gpm	Process Area
TP-AB-1	Air Blower	New York Blower	2612 Alum	H 11932 100	3865 cfm	Process Area
TP-AB-2	Air Blower	New York Blower	2612 Alum	H 11932 100	3865 cfm	Process Area
TP-MT-1	Mixing Tank	Plastic Pipe & Supply	92-A-605		300 gallon	Process Area
TP-MT-2	Mixing Tank	Plastic Pipe & Supply	92-A-605		300 gallon	Process Area
TP-MIX-1	Mixer	Lightnin	XJ-30	B60016-1		Process Area
TP-MIX-2	Mixer	Lightnin	XJ-30	B60016-2		Process Area
TP-AIR-1	Air Compressor	Dayton	1Z941D		.5 HP	Process Area

Source: CRREL

Pumps P-7 and P-8 pump from Reservoir No. 2 at the TCE Treatment Facility to the Frost Effects Research Facility (FERF) for NCCW purposes. These pumps are not used year round.

Table 1-2 Information on Existing Wells

Well	Depth to Top of Screen, feet	Motor Horsepower	Capacity, gpm
No. 1	113.5	30	450
No. 2	127	30	450
No. 3	130	30	450
No. 4	113	Unknown	Unknown
No. 5	108	20	350

gpm – gallons per minute

Source: CRREL

NCCW System 2

Water from Well No. 3 does not require treatment for TCE removal. Thus untreated water is used for NCCW. The well water is pumped to an underground reservoir and then pumped into Ice Engineering for NCCW. The NCCW water then discharges into a stormwater collection system, which eventually discharges into the Connecticut River near Navy Pond. None of the water from Well No. 3 is used for building cooling systems. Pumps P-1 and P-2 at the TCE Treatment Facility can also pump to NCCW System 2 (Ice Engineering). However, this has never been done.

Background Information

A copy of the NPDES Permit for the NCCW water from CRREL is in Appendix B. Included in this permit are requirements that the discharge to the Connecticut River meets the following criteria:

TCE, maximum daily value	5 micrograms per liter
pH	6.5 to 8.0

CRREL is required to test for TCE monthly and pH, three times per week. Since stormwater enters the NCCW system, tests are required when no rainfall has occurred within the last 24 hours. Usually, but not always, this has been possible.

Several treatment facilities have been added to the CRREL site to meet the limits of this permit.

In early 1994, a permanent TCE treatment facility became operational. This facility included a potassium permanganate feed system, GSF, and air stripping towers. The treated water was then used for NCCW prior to discharging to the Connecticut River.

In 1995, the carbon dioxide feed system was added because calcium carbonate deposition was a problem in Reservoirs 1 and 2. Carbon dioxide was released in the air stripping towers, causing the pH of the water to increase and calcium carbonate precipitates to form.

The backwash water from the GSF initially discharged to the Connecticut River. However, changes were needed due to the total suspended solids levels in the GSF backwash water exceeding the 50 mg/L limit in the NPDES Permit. Thus, in 2005 a temporary holding tank for GSF backwash wastewater was added. The water from this tank is slowly discharged to the City of Hanover's sanitary sewer system.

In October 2006 the packing material in Tower 1 was replaced. Packing material in Tower 2 was replaced in May 2007. The packing material required replacement due to excessive deposits in the packing material.

Since March 2006, the NPDES pH limit of 8.0 for the NCCW has been exceeded occasionally. As required, CRREL sent a notification letter to EPA on each occasion. Currently routine samples are only collected at the Navy Pond Manhole. Total volumes of water pumped and hours of operation for each well are currently reported to EPA.

EPA is considering having CRREL move its sampling site for determination of compliance and to possibly have more sites measured. Also, EPA may require flow measurement at various locations.

The NPDES Permit allows the maximum pH limit to increase to 9.0 if approved by the New Hampshire Department of Environmental Services (NHDES). CRREL is currently pursuing getting this variance from NHDES. Application for this variance includes providing flow rate and pH information for Connecticut River and performing lab tests to determine the effect of blending NCCW discharge with the river water. Eastern Analytical (EA) performed this work for CRREL and the results are presented in Appendix C.

Section 2

Data

Data on water usage and water quality tests for the noncontact cooling water (NCCW) systems are presented in this section.

Water Usage Data

The water usage data for the year 2006 is summarized in Table 2-1. The raw data for January 2006 through September 2007 is included in Appendix D. Only the data from 2006 was summarized such that seasonal fluctuations would be accounted for adequately.

The 2006 average daily flow rate through the trichloroethylene TCE treatment facility was 598,000 gallons per day (gpd) or 420 gallons per minute (gpm). The peak daily flow rate was 1 million gpd (700 gpm). The flow rate from Well No. 3 (NCCW System 2) averaged 147,000 gpd with a maximum rate of 626,000 gpd. The actual pumping rate from Well No. 3 probably did not vary as much as the table indicates. (Pumping rates for when the pump operated for short durations cannot be calculated accurately.)

Water Quality Data

Table 2-2 summarizes the historical water quality data and the primary findings from each source. The complete water quality data from these sources is included in Appendices E through M.

Eastern Analytical Tests

Eastern Analytical, Inc. (EA) performed sampling and water quality tests as part of this study. The sampling locations are shown in Figures 2-1 and Figures 1-1 and 1-2. Sampling methods and results are given in Appendix E, which is bound separately.

Onsite testing was performed for pH, temperature, and conductance. Grab samples were collected on four separate days and laboratory tests were performed for various parameters.

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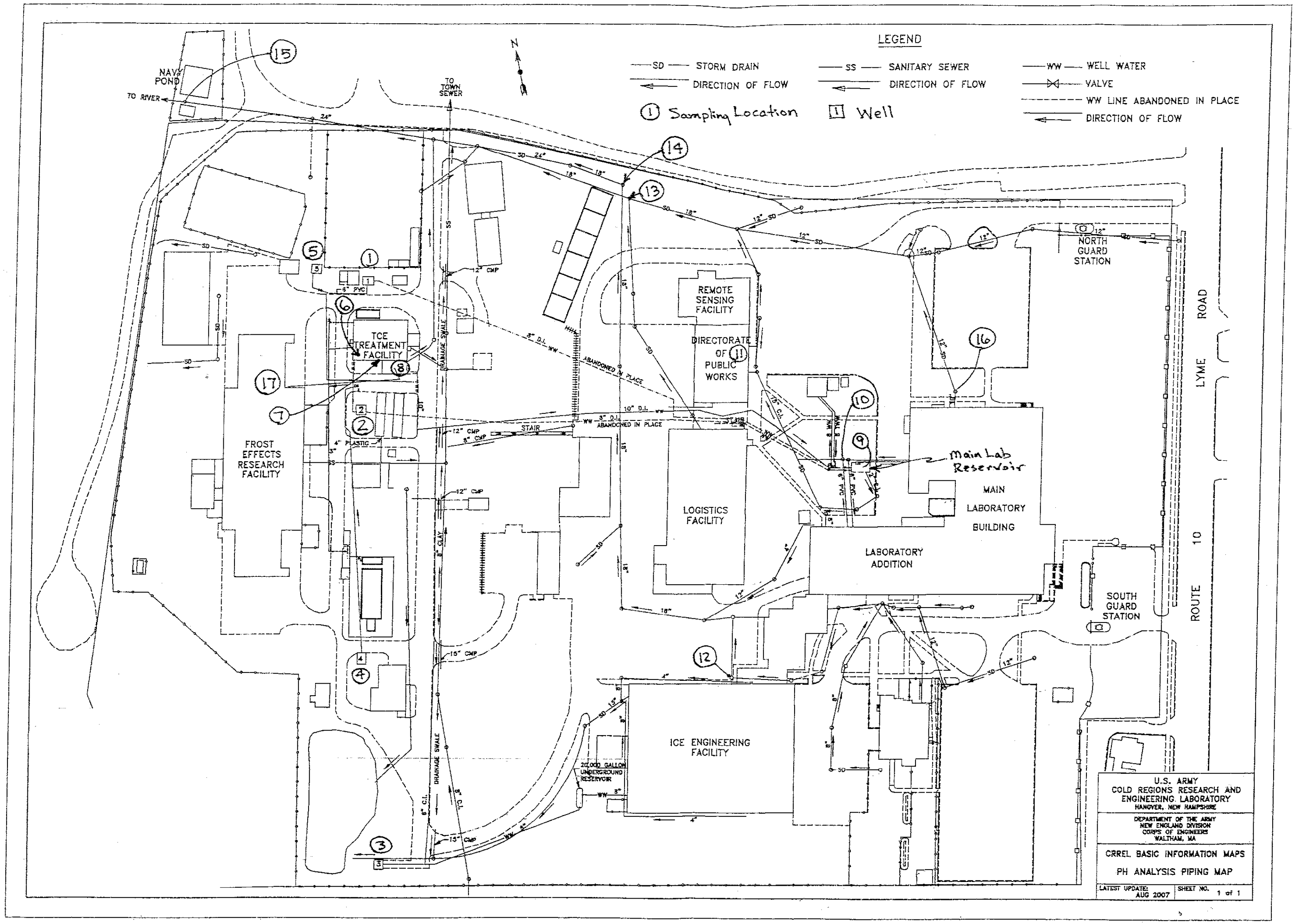


Sampling Locations for August & September

Figure 2-1

Continuous monitoring for pH, conductance, and temperature was performed at five locations – Manhole 10, 12, 13, and 14 and Well No. 3. The goal was to monitor the trend in water quality as the water passed through the two NCCW systems. Manhole 10 and Manhole 13 are locations on NCCW System 1. Manhole 10 was the first reliable sampling location downstream of the carbon dioxide feed point. The Main Lab Reservoir was not used due to the probable inconsistent water quality throughout the reservoir. Well No. 3, Manhole 12 and Manhole 14 are locations on the NCCW System 2. Results are presented in Section 3.

The most extensive testing was done on the first grab sample collected on August 13th. The results for this sample are presented in Table 2-3.

Sections 3 and 4 further discuss EA test results as they pertain to the subject of concern.

Table 2-1 Well Water Usage Data for 2006

Well(s)	No. of Days Used	Maximum Pumped Volume per Day, gallons	Average Pumped Volume per Day, gallons	Maximum Pumping Rate, gpm	Average Pumping Rate, gpm	Total Usage in 2006, gallons
1	220	470,000	296,000	430	320	65,000,000
2	311	537,000	342,000	400	350	106,000,000
3	286	626,000	147,000	460	280	42,000,000
4	355	111,000	1,000	270	160	356,000
5	259	383,000	206,000	340	250	53,000,000
1,2,3,4,5	365	1,199,000	732,000	CD	CD	267,000,000
1,2,4,5	365	1,001,000	598,000	CD	CD	218,000,000

Notes:

1. Average pumped volumes for individual wells is based on only days when well is used.
2. See Appendix D for raw data.

CD - cannot determine from available data

gpd – gallons per day

gpm – gallons per minute

Source: Stanley Consultants, Inc.

Table 2-2 Available Water Quality Data

		Sample Locations							Tests						
Source	**Sample Dates**	**Wells**	**GSF Influent**	**GSF Effluent**	**Towers**	**Main Lab Reservoir**	**Navy Pond MH**	**Other**	**pH**	**Temperature**	**TCE**	**Iron**	**TOC**	**Other**	**Primary Results**
EA 2007 Tests (Appendix E)	8/2007 and 9/2007	x	x	x	x	x	x	See Appendix E	x	x		x	x	See Appendix E	See discussion later in this report
CRREL pH Reports (Appendix F)	3/2006 - 9/2007						x		x	x					Exceeded pH of 8.0 several times
CRREL TCE Reports (Appendix G)	1993-2007		x	x			x				x	x		Mn	See Section 4
CRREL (Appendix H)	9/1/2006	x		x	x	x									pH increase across towers; CO_2 reduces pH
CRREL Toxicity Report (Appendix I)	1/2006						x	Connecticut River	x	x			x	See Appendix I	----------------
T&M Assoc (Appendix J)	6/29/95				x	x	x	Bag filters	x	x				Calcium Alkalinity	pH decreases due to CO_2 addition
CRREL (Appendix K)	6/8/2005	x			x	x	x		x	x					pH increase across towers; pH increase from Main Lab Reservoir to Navy Pond MH

Table 2-2 Available Water Quality Data – Continued

Source	Sample Dates	Sample Locations							Tests						Primary Results
		Wells	GSF Influent	GSF Effluent	Towers	Main Lab Reservoir	Navy Pond MH	Other	pH	Temperature	TCE	Iron	TOC	Other	
Draft, Investigation of Scaling in Heat Exhanger System Piping, March 21, 1993 (Appendix L)	1/23/1995	x		x	x		x	See Appendix L	x	x		x	x	See Appendix L	Increase in pH and calcium carbonate precipitation potential across towers
1995 TCE Treatment Facilities Contract Documents, Section 13548 (Appendix M)	unknown	x							x		x	x	x	Hardness, Mn, Alkalinity, Sulfate, Nitrate, TDS, TS, Nitrite, Barium, Copper, Zinc	------------------

AA - Aquarian Analytical Inc.
EA - Eastern Analytical Inc.
GSF - Greensand Filters
MH - manhole
Mn - Manganese

TCE - Trichloroethylene
TDS - Total Dissolved Solids
TOC - Total Organic Carbon
TS - Total Solids
Towers - Air Stripping Towers

Source: Stanley Consultants, Inc.

Table 2-3 Results of Water Quality Tests for August 13, 2007

Sample Location No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Parameter	**Units**	**MDL**	**Well 1**	**Well 2**	**Well 3**	**Well 4**	**Well 5**	**GSF Influent**	**Tower One Influent**	**Tower Two Effluent**	**Main Lab Reservoir**	**MH 10**	**Discharge from Public Works Bldg Cooling System (in bldg)**	**MH 12 near Ice Engr.**	**MH 13**	**MH 14**	**Navy Pond MH**	**MH 16**
Calcium	mg/L	0.05	100	77	70	73	78	76	78	78	84	78	77	71	76	70	75	ND
Total Iron	mg/L	0.05	0.67	0.33	0.28	0.11	0.39	0.27	< 0.05	< 0.05	ND	< 0.05	ND	1.5	< 0.05	0.43	ND	ND
Dissolved Iron	mg/L	0.05	0.47	0.27	0.15	< 0.05	0.29	0.19	< 0.05	< 0.05	ND	< 0.05	ND	< 0.05	< 0.05	< 0.05	ND	ND
Organically-bound Iron	mg/L	0.05	0.49	0.29	0.15	< 0.05	0.29	0.19	< 0.05	< 0.05	ND	< 0.05	ND	< 0.05	< 0.05	< 0.05	ND	ND
Total Magnesium	mg/L	0.05	11	10	9.8	11	8.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.9	ND
Total Manganese	mg/L	0.005	0.13	0.11	0.085	0.022	0.040	0.064	0.068	ND	ND	ND	ND	ND	ND	ND	0.009	ND
Dissolved Manganese	mg/L	0.005	0.14	0.11	0.086	0.023	0.041	0.065	0.070	ND	ND	ND	ND	ND	ND	ND	0.006	ND
Total Potassium	mg/L	0.05	5.7	5.2	4.2	4.7	4.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.9	ND
Total Silicon	mg/L	0.05	ND	ND	5.5	ND	ND	4.8	ND	ND	ND	ND	ND	ND	ND	ND	5.0	ND
Total Sodium	mg/L	5	ND	ND	9	ND	ND	23	ND	ND	ND	ND	ND	ND	ND	ND	21	ND
Total Hardness	mg/L as $CaCO_3$	0.05	300	230	220	230	230	230	240	240	250	240	230	220	230	210	230	ND
Total Solids Suspended	mg/L	2	ND	ND	< 5	ND	ND	< 5	ND	< 5	ND	ND	ND	ND	< 5	< 5	< 5	ND
Total Dissolved Solids	mg/L	5	550	360	300	310	380	360	370	360	390	360	370	290	370	310	350	ND
Sulfate	mg/L	1	32	ND	34	ND	ND	36	ND	36	ND	ND	ND	ND	36	34	35	ND
Total Alkalinity-M	mg/L as $CaCO_3$	1	190	150	150	150	150	150	150	150	150	150	150	150	150	150	150	29
Dissolved Alkalinity-M	mg/L as $CaCO_3$	1	ND	ND	ND	ND	ND	ND	150	150	ND	150	ND	150	150	140	ND	ND

Table 2-3 Results of Water Quality Tests for August 13, 2007 - Continued

Sample Location No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Parameter	**Units**	**MDL**	**Well 1**	**Well 2**	**Well 3**	**Well 4**	**Well 5**	**GSF Influent**	**Tower One Influent**	**Tower Two Effluent**	**Main Lab Reservoir**	**MH 10**	**Discharge from Public Works Bldg Cooling System (in bldg)**	**MH 12 near Ice Engr.**	**MH 13**	**MH 14**	**Navy Pond MH**	**MH 16**
Total Alkalinity-P	mg/L as $CaCO_3$	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Dissolved Alkalinity-P	mg/L as $CaCO_3$	1	ND	ND	ND	ND	ND	ND	< 1	< 1	ND	< 1	ND	< 1	< 1	< 1	ND	ND
CO_2 (Free)	mg/L	NA	17	5	6	6	5	6	5	2	3	16	13	4	7	1	4	ND
TOC	mg/L	0.5	0.6	0.7	< 0.5	< 0.5	0.6	0.6	ND	< 0.5	ND	ND	ND	ND	0.5	0.5	0.5	ND
Lab pH	SU	NA	7.2	7.6	7.7	7.7	7.6	7.7	7.7	8.0	7.3	7.3	7.2	7.8	7.6	8.0	7.8	7.8
Heterotrophic Plate Count	CFU/ml	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	7	ND	ND	4400	ND
Specific Conductance Lab	µmho/cm	1	830	610	490	540	630	600	600	600	630	620	610	490	600	490	570	130
Field Temperature	Celsius	NA	12	11	12	11	11	12	12	16	14	18	21	13	18	16	22	26
Field pH	SU	NA	7.3	7.1	7.4	7.1	7.3	7.4	7.2	7.8	6.8	6.8	6.8	7.8	7.0	7.6	7.4	7.7
Field Conductivity	µmho/cm	1	ND	ND	500	ND	ND	ND	ND	ND	ND	640	ND	ND	630	490	ND	ND

µmho/cm – micromhos per centimeter

CFU/ml – colony-forming units per milliter

MDL – minimum detection limit

mg/L – milligrams per liter

N/A – not applicable

ND – not determined

SU – standard units

TOC – Total Organic Carbon

Source: Eastern Analytical, Inc.

Section 3

pH Level Control

Introduction

The discharge of the noncontact cooling water (NCCW) system has exceeded the NPDES pH limit of 8.0 occasionally during the last couple years. CRREL is in the process of requesting a variance from New Hampshire Department of Environmental Services (NHDES) to allow the pH level to increase to 9.0.

For NCWW System 1, the pH of the water increases as it flows through the air stipping towers due to the evolution of carbon dioxide. The pH of the water is subsequently decreased by adding carbon dioxide. The pH has been observed to increase as it flows through the system from the carbon dioxide feedpoint to the Navy Pond Manhole.

For NCCW System 2, the pH of the water has been observed to increase as it flows from Well No. 3 to the Navy Pond Manhole.

This study examines why the pH of the NCCW is changing and presents alternatives for CRREL to come into compliance with the NPDES permit.

General Discussion on pH

pH is the measure of the hydrogen ion concentration. It is the negative log of the H^+ concentration. Thus a solution with $10^{-7.4}$ molar concentration of H^+ has a pH of 7.4.

Water is considered neutral if the concentration of H^+ and OH^- concentrations are the same. The pH at which this occurs varies with temperature. Thus a neutral water sample at a temperature of 25°C has pH of 7.0. Whereas, a neutral sample at a temperature of 15°C has a pH of 7.18.

A solution of pH of less than 7.0 is considered acidic. A pH of greater than 7.0 is considered basic. Some solutions are buffered, meaning that there is little pH change when an acid or base is added. Bicarbonate, which is present in the water in this study, is a buffer.

Carbonate System Description

Since the carbonate system plays a significant role in determining the pH, a brief background on the carbonate system is presented.

The carbonate system is the most important acid-base system in water. The carbonate species are made up of the following species—gaseous carbon dioxide (CO_2), dissolved CO_2, carbonic acid (H_2CO_3), bicarbonate (HCO_3^-) and carbonate (CO_3). Because it is difficult to distinguish between aqueous CO_2 and H_2CO_3 by analytical procedures, a hypothetical species, $H_2CO_3^*$, is used to represent aqueous CO_2 plus H_2CO_3. The latter, which is a relatively strong acid, only makes up 0.16 percent of the $H_2CO_3^*$. H_2CO_3 is the portion that participates in chemical reactions. For purposes of this report, "carbon dioxide" will be used instead of $H_2CO_3^*$.

The amount of CO_2 in the water is dependent on whether it is an open or closed system. In an open system (water open to the atmosphere) the amount of CO_2 in the water at equilibrium with the atmosphere is limited by the partial pressure of carbon dioxide in the atmosphere. A water sample equilibrated to the atmosphere will have a CO_2 concentration of 1×10^{-5} M or 0.44 mg/l as CO_2. If the water sample is in an essentially closed environment, much more carbon dioxide can be dissolved in the water (3.5 g/L at 0°C and 1.5 g/L at 25°C). Basins that are essentially closed and bodies of water with low surface area to volume ratios are considered closed.

The bicarbonate in the water samples in this study essentially accounts for all the alkalinity in the water. Bicarbonate provides buffering capacity of the water. Most of the samples collected in this study had a bicarbonate concentration of about 150 mg/L as $CaCO_3$.

The actual concentrations of the various carbonate species can be complicated by the presence of complexing agents. In most cases, it is sufficient to make simplifying assumptions such that concentrations of carbonate species can be determined. Carbon dioxide concentrations are difficult to determine, however. Titration methods are affected by the exposure of the sample to the atmosphere. An alternative method uses a nomograph and data on pH, alkalinity, temperature and total dissolved solids. However, a slight error in pH measurement can give a significant error in carbon dioxide concentration using the nomograph. Samples collected on August 13 were tested for carbon dioxide using the titration method. However, due to the interference with the atmosphere the results were unreliable.

pH Testing

In order to make comparisons of pH data, it is important that the pH meters are working correctly and being used properly. Also, it is important that the samples are handled carefully such that dissolution or absorption of carbon dioxide is minimized.

The pH meters used in the study have the temperature-compensating feature. This means that the meter automatically compensates for the temperature of the solution being tested. This is important because the sensitivity of the pH probe varies with solution temperature.

During the site visit in July, a side-by-side comparison of CRREL's pH meter and Eastern Analytical, Inc. (EA) meter was performed for analysis of the pH in the Navy Pond Manhole. It was found that CRREL's meter measured higher (pH of 7.6 vs. 7.9). During subsequent site visits by EA, additional side-by-side testing was done. On September 7th, a comparison was made between two of EA meters and CRREL's meter. The two EA meters gave similar results while the CRREL meter gave consistently higher results. The calibration readings for the CRREL meter indicated that the pH probe and/or meter were not performing optimally, as determined by the meter manufacturer. Specifically, when a slope reading of less than 96 percent is obtained, the meter is unreliable.

Based on these results, the following recommendations were made to CRREL, most of which have been adopted:

- CRREL's pH probe should be reconditioned overnight by immersing in a buffer solution of pH of 4. If a slope reading of greater than 96 percent is not achieved, replace the probe.
- When the meter is not in use, the pH probe should be kept hydrated by immersing in a buffer solution or an electrolyte solution.
- When "cleaning" the probe between buffer solutions, rinse first with distilled water and then the next buffer.
- Never rub the probe. If need to dry the probe, tap probe gently on side of container or dab with Chem. Wipes.
- When testing the 9.0 buffer after calibration, if a reading deviation of greater than 0.1 is achieved, recalibrate until results are satisfactory.
- Comparison of portable meter with bench scale meters on a regular basis.
- Have two portable meters on hand and alternate use.

It is also recommended that the inline pH meter in the Main Lab be tested if it hasn't been recently.

Information on the various pH meters used in the study is given below.

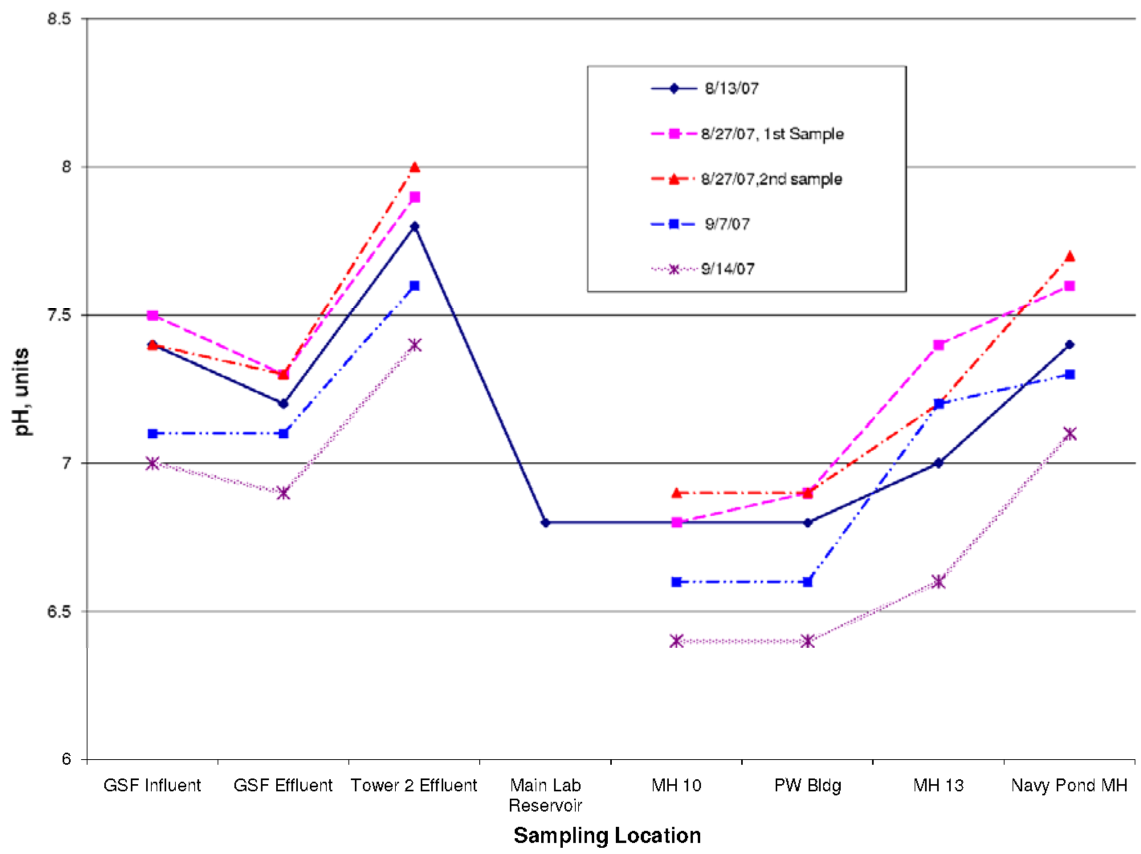
Table 3-1 Data on pH Meters Used in Study

Owner	Type	Manufacturer and Model
CRREL	Portable	Schott CG 837 meter with Schott Blueline 29 pH-P probe, C060422 029
CRREL	Inline	
Eastern Analytical, Inc.	Bench Scale	Orion 250A Bench pH Meter
Eastern Analytical, Inc.	Portable	WTW 340i pH/Conductance Meter
Eastern Analytical, Inc.	Portable	Orion 260
Eastern Analytical, Inc.	Continuous Monitoring	YSI 600XLM Sonde

Source: Stanley Consultants, Inc.

Sources of pH Increase

The pH results for grab samples collected in August and September are shown in Figures 3-1 and 3-2. For NCCW System 1, the pH generally decreases as it goes through the GSF and increases through the air stripping towers, due to carbon dioxide being evolved. The pH measured in the Main Lab Reservoir and Manhole 10 is less than the effluent from air stripping tower 2 due to the carbon dioxide addition. After the Public Works Building, the pH increases.



Field pH Results for NCCW System 1

Figure 3-1

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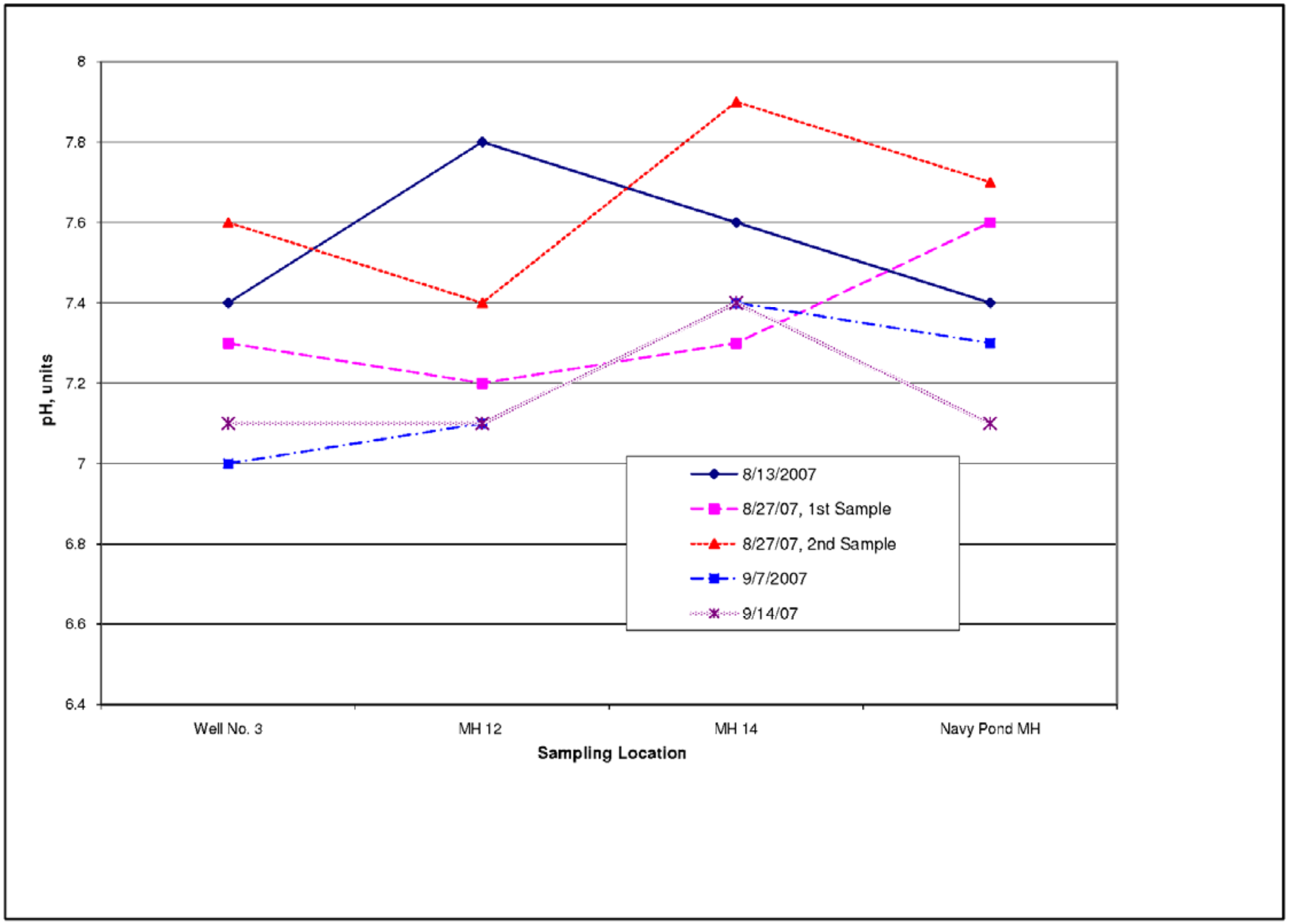

Field pH Results for NCCW System 2
Figure 3-2

The pH results for NCCW System 2 shows a pH increase from Well No. 3 to Manhole 14. The relationship of pH between Well No. 3 and Manhole 12 was not consistent. Note that both NCCW systems combine before the Navy Pond Manhole.

The pH results for the continuous monitoring are shown in Figures 3-3 through 3-5. For the NCCW System 1, there was a consistent increase in the pH as NCCW flowed from Manhole 10 to 13. Midway through the monitoring the analyzers were switched between the two manholes to rule out the possibility of differences in the analyzers causing the different pH readings. There were spikes in the pH caused by discontinuous feed of carbon dioxide.

The pH results for the continuous monitoring of NCCW System 2 showed a significant increase from Well No. 3 to Manhole 14. There was little difference in pH readings between Manhole 12 and Manhole 14.

Potential sources for the increase in pH in the NCCW system as it flows through the system are discussed below:

1. Addition of flows from CRREL facilities. Dye testing was performed by CRREL in 2002 to determine what lines discharge into the NCCW system. Several floor drains, which received discharges from area equipment, were tied into the NCCW system. Those equipment discharges were rerouted to the sanitary sewer system and floor drains were plugged. At the site visit in July, upstream manholes on storm sewers that discharged into the NCCW systems were checked for flows. None of the manholes had flow except there was an unknown low flow from MH 16 near the north side of the Main Lab (see Figure 1-1). Analysis of the flow indicated it was low in alkalinity (29 mg/L as $CaCO_3$) and had a pH of 7.7. Since the flow rate is low and the NCCW has a high alkalinity (buffering capacity), MH 16 flow would have little effect on the pH of the total flow at the Navy Pond MH. CRREL is in the process of identifying and eliminating the flow from MH 16 into the NCCW discharge system.
2. Addition of stormwater. This is not a concern since NPDES compliance is determined during non-rainfall events. However, as shown in the continuous monitoring graphs, the rainfall events in August and September had little or no effect on pH at the locations tested.
3. Dissolution or precipitation of chemicals. Pipe materials may be dissolving into the water or chemicals may be precipitating from the water as it flows through the system. Corrosion indices for the NCCW indicate that the water is corrosive after the carbon dioxide feed point. Dissolution of previously deposited materials on the interior of the pipe or of the pipe itself may be occurring.
4. Naturally occurring chemical changes in the water due to biological activity. During the July site visit, significant biological growth was occurring in the Main Lab Reservoir. This reservoir has open lids allowing rainfall and sunlight to enter the reservoir. The type of biological growth in this reservoir however, is not expected to cause the pH to change significantly. If iron bacteria were present, they could cause the pH to decrease, not increase.

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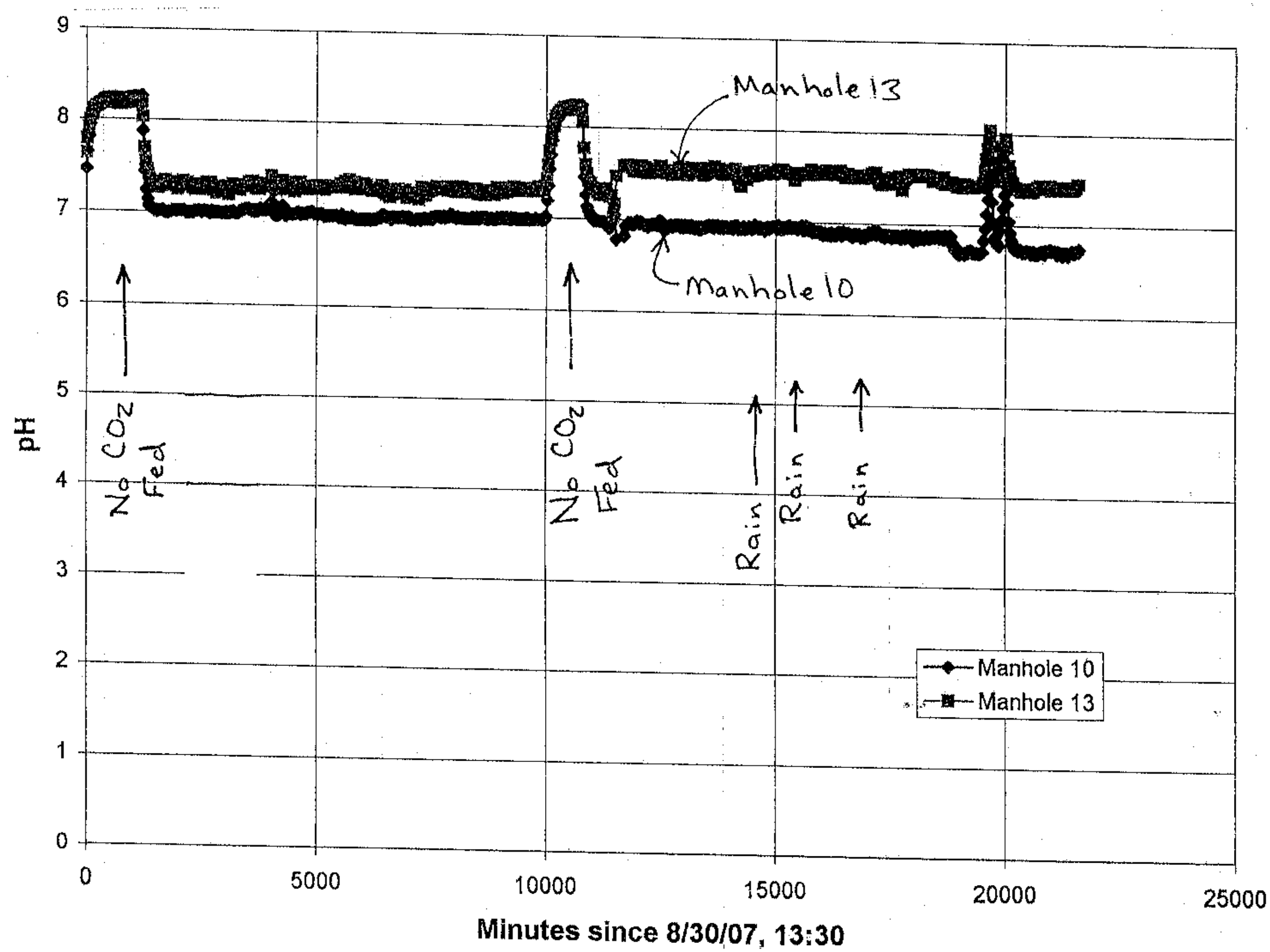

Continuous Monitoring Results-Manholes 10 and 13

Figure 3-3

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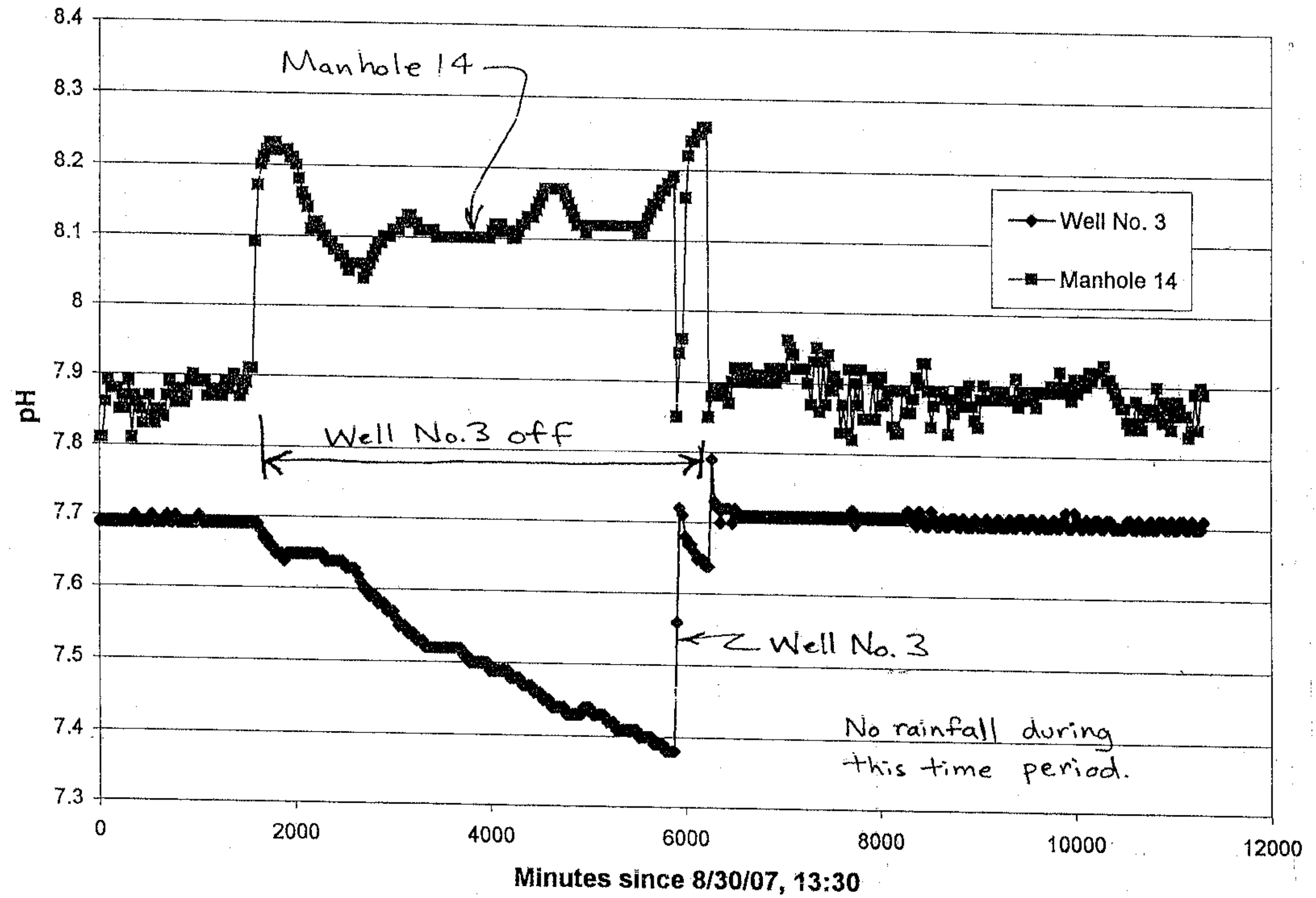

Continuous Monitoring – Well No. 3 and Manhole 14

Figure 3-4

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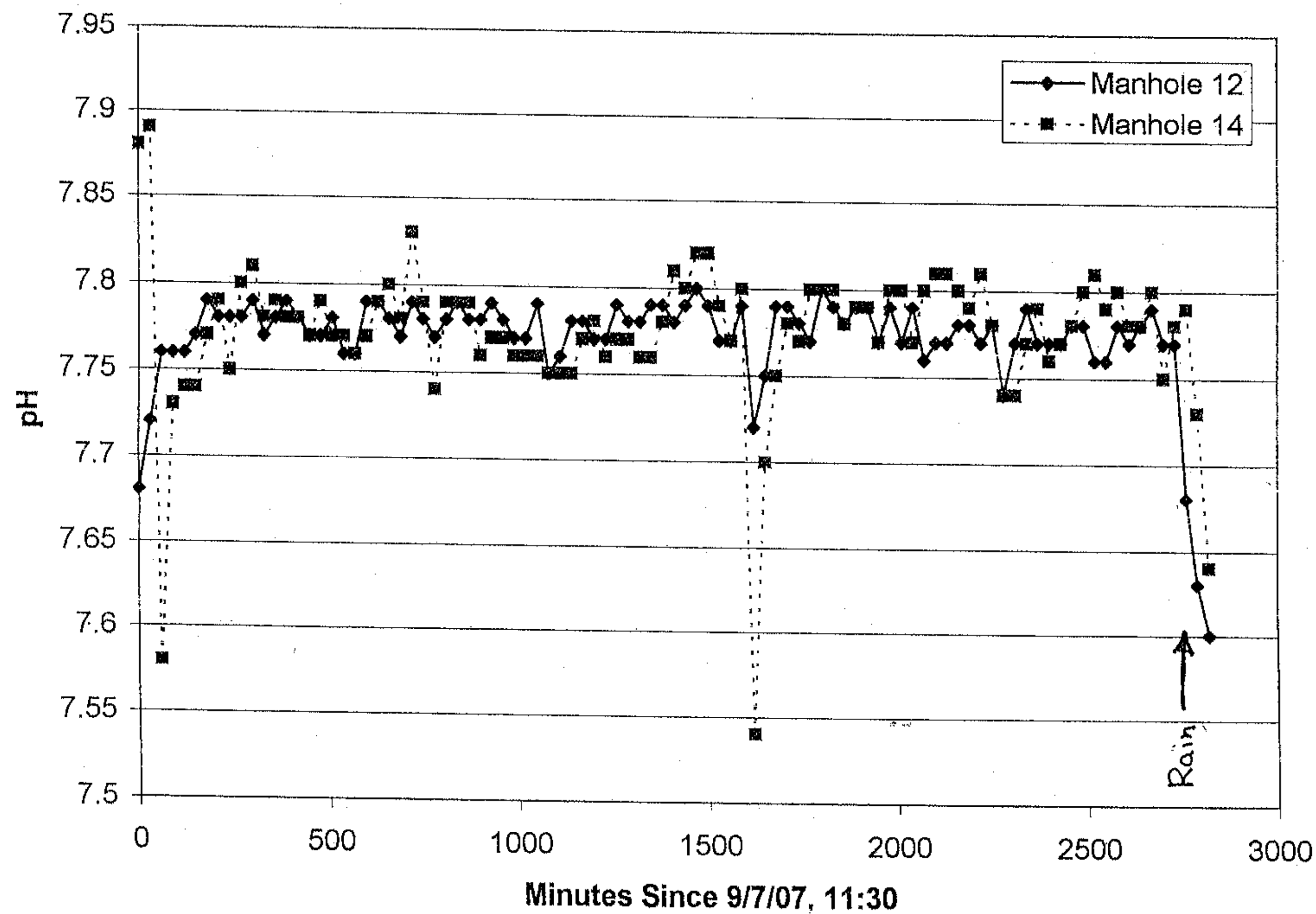

Continuous Monitoring Results-Manholes 12 and 14

Figure 3-5

5. Naturally occurring chemical changes in the water due to water chemistry. When water is exposed to the atmosphere, the water strives to come into equilibrium with the carbon dioxide in the air. As the NCCW flows through the system, carbon dioxide is being evolved causing the pH to decrease. Given enough time and exposure to the atmosphere, the dissolved carbon dioxide concentration in the NCCW would decrease to 0.44 mg/L and the pH of the water would rise and calcium carbonate would possibly precipitate out.

   This is true for both NCCW systems. The discharges into the manhole downstream of Manhole 12 (NCCW System 2) and at Manhole 13 (NCCW System 1) are elevated allowing significant water/air contact thereby improving conditions for carbon dioxide evolution. A sample from MH 10 was allowed to set open to the atmosphere in the lab for several hours. During this time, the pH increased from 7.2 to 7.8. Even though carbon dioxide is not added to NCCW System 2, the groundwater has carbon dioxide in it, which is released as the water flows toward the Navy Pond MH causing the pH to increase.

Based on the above discussion, it appears that the primary reason for the NCCW's pH increasing as it flows toward the Navy Pond MH is due to the natural evolution of carbon dioxide.

Alternative pH Control Methods

Currently carbon dioxide, an acid, is added at Reservoirs 1 and 2 to reduce calcium carbonate precipitation and to lower the pH of NCCW System 1. Nothing is currently done to adjust the pH in NCCW System 2.

A summary of the alternatives considered for pH compliance are given in Table 3-2. Two alternatives for adjusting the pH are presented, the existing carbon dioxide system and a sulfuric acid system.

Table 3-2 Summary of Alternatives for pH Compliance

Alternative	Description	Pros	Cons	Costs
NPDES variance	Obtain variance from NHDES to raise pH limit to 9.0	Limit unlikely to be exceeded Usage of carbon dioxide decreases	None	Only administrative and tests associated with obtaining variance
Carbon Dioxide at TCE Treatment Facility	Continued addition of CO_2 at Reservoir 1 and 2 and discharge of High Lift Pumps Use only for water stabilization	Reduces calcium carbonate precipitation Carbon dioxide feed system is simple	Carbon dioxide is expensive relative to other chemicals such as sulfuric acid	Capital cost for 3 separate feed systems - $19,000 Annual chemical cost - $28,000 (See Note 1)

Table 3-2 Summary of Alternatives for pH Compliance (Continued)

Carbon Dioxide at Navy Pond Manhole	Add carbon dioxide to adjust pH below NPDES limit	System easy to operate Feed point close to river discharge point	Requires new chemical feed system Carbon dioxide is expensive relative to other chemicals such as sulfuric acid	Capital cost - \$41,000 (See Note 2) Annual chemical cost - \$8,800 (See Note 3)
Sulfuric Acid	Add sulfuric acid instead of carbon dioxide at TCE Treatment Facility and at Navy Pond	Chemical costs less than CO_2	Sulfuric acid is corrosive and more difficult to handle than carbon dioxide	Capital cost for two chemical feed systems - \$80,000 (See Note 2) Annual Chemical cost - \$6,800 (See Note 4)

Note:

1. Based on total feed rate of 24 mg/L, average flow rate treated is 600,000 gpd, and cost of carbon dioxide is \$0.65 per pound.
2. Assumes existing building at Navy Pond does not require structural or HVAC modifications. Assumes sufficient power available at Navy Pond building. Sulfuric Acid system at TCE facility includes removal of potassium permanganate system.
3. Based on total feed rate of 6 mg/L, average flow rate treated is 730,000 gpd, and cost of carbon dioxide is \$0.65 per pound.
4. Based on total feed rate of 9 mg/L at TCE Treatment Facility and 7 mg/l at Navy Pond Manhole. Average flow rate treated is 600,000 gpd at TCE Treatment Facility and 730,000 gpd at Navy Pond Manhole. Cost of sulfur dioxide is \$0.20 per pound (excluding shipping).
5. Cost estimates presented are Stanley Consultants' opinions of probable project and construction costs. Costs estimates are made based on Stanley Consultants' experience and best judgment. The construction costs are based on current prices. The estimates do not include inflation. Stanley Consultants has no control over cost of labor, materials, equipment, contractor's methods, or competitive bidding or market conditions. Therefore, Stanley Consultants does not guarantee that actual construction costs will not vary from cost estimates presented.

Source: Stanley Consultants, Inc.

NPDES Variance

As stated earlier, CRREL is in the process of requesting a pH variance from the NPDES permit such that the upper limit will be 9.0. If this variance is obtained, then no treatment is needed to keep the discharge in compliance with the NPDES pH requirement. The water with the characteristics observed in this study naturally will not exceed a pH of 9.0.

Carbon Dioxide Feed System

The schematic of the existing carbon dioxide feed system for NCCW System 1 is shown in Figure 3-6. Information on the equipment is also shown on this figure.

Carbon dioxide gas is fed from one of two 350-pound liquid carbonic acid cylinders. The carbon dioxide feed rate is manually controlled. There is an automatic switchover such that the source of carbon dioxide can be automatically switched to the other cylinder when the first is exhausted. The carbon dioxide is fed into a water line using an ejector. A booster pump supplies water from the discharge line of Pumps P-1 and P-2 to the ejector. The carbon dioxide solution line feeds to three locations: the discharge of Pumps P-1 and P-2, Reservoir 1, and Reservoir 2.

(Note that the size of the elements in pounds per day (ppd or lbs/day) in Figure 3-6 refer to if chlorine gas was being fed. The actual carbon dioxide feed rate is 78% of these numbers.)

Prior to August 2007, carbon dioxide was fed to all three locations. A brief study in August indicated better pH reduction by only feeding the reservoirs. Therefore, since then, carbon dioxide has only been fed to the reservoirs.

Discussions with Severn Trent (a division of Capital Controls) indicate that the system is sized correctly for a 500 pounds per day (ppd) system except for the booster pump. The booster pump currently installed could supply enough water to feed 200 ppd or 156 ppd of carbon dioxide. At a flow rate of 600,000 gpd (average flow rate in 2006), this corresponds to a feed rate of 31 mg/L. At a maximum desired flow rate of 1.2 million gallons per day (850 gpm). This corresponds to a feed rate of 15 mg/L.

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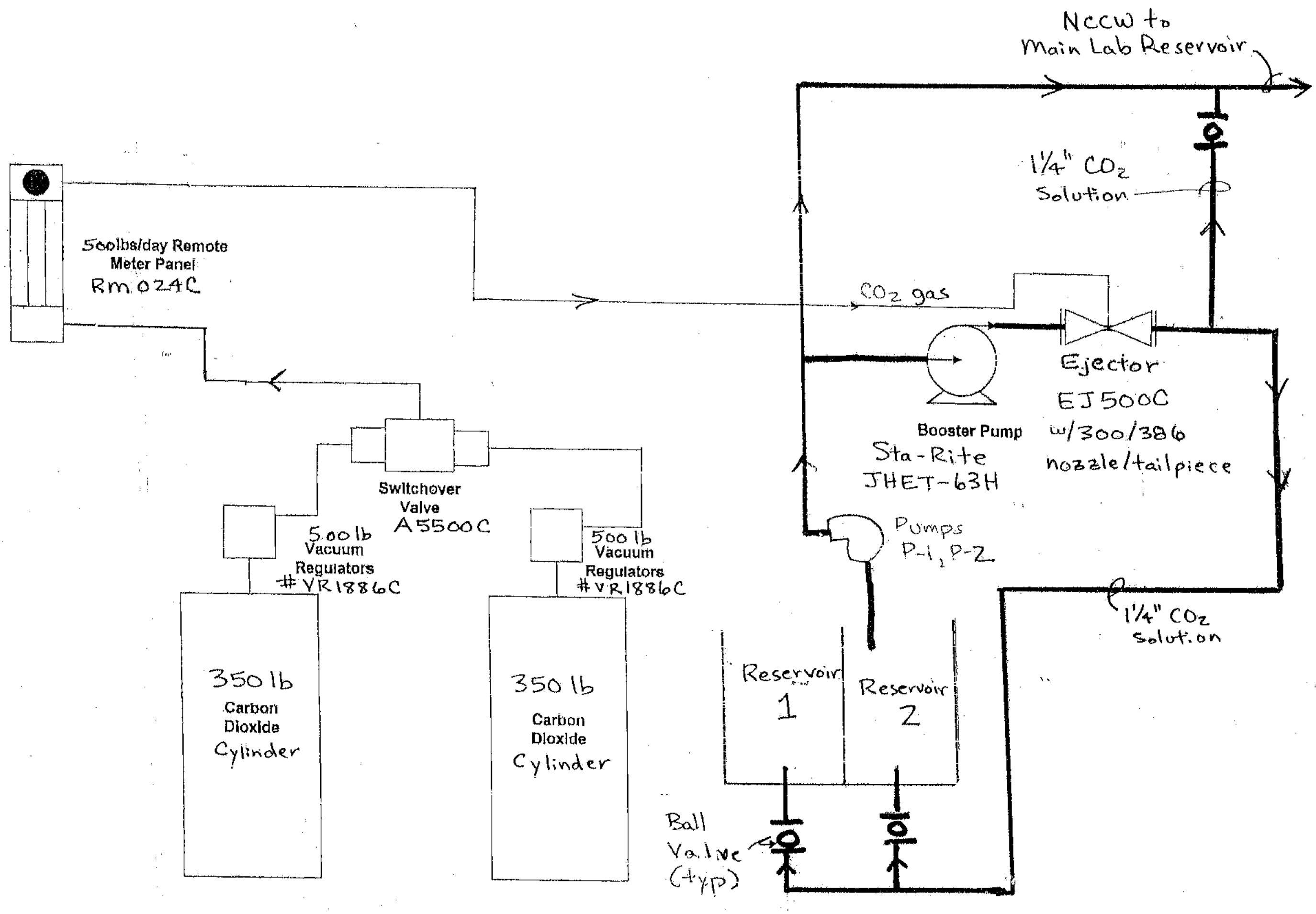

Schematic of Existing CO_2 System

Figure 3-6

The carbon dioxide is reducing the pH of the water as shown in the figures previously presented in this section. The more carbon dioxide added, the lower the initial pH and the less amount of carbon dioxide that is lost to the atmosphere as the NCCW flows towards the Navy Pond Manhole. Thus a higher carbon dioxide feed rate corresponds to a lower pH at the Navy Pond Manhole.

If feeding of carbon dioxide continues at the TCE treatment facility, a separate 200 ppd meter panel and ejector should be installed on each of the three feed lines to better monitor the feed rates. A schematic of the proposed system is shown in Figure 3-7. Only the line feeding into the discharge of pumps P-1 and P-2 would need a booster pump. The booster pump and ejectors should be installed inside for year-round accessibility. A feed rate of 12 mg/L of carbon dioxide to a flow rate of 850 gpm corresponds to 120 ppd of carbon dioxide. Thus a 200 ppd system would be adequate. (Theoretically a maximum feed rate of about 8 mg/L is required to achieve water stability. Due to losses, a 50% factor is included giving a total feed rate of 12 mg/L.) The intention is to be able to feed 12 mg/L at Reservoir 1; and that the combined feed rate to Reservoir 2 and discharge from Pumps P-1 and P-2 be 12 mg/L. Most of the carbon dioxide fed to Reservoir 1 is probably lost in the second tower. Feeding to the discharge from Pumps P-1 and P-2 has the advantage of less carbon dioxide lost to the atmosphere than from the Reservoir 2 feed point.

Sulfuric Acid System

Sulfuric acid is an alternative to carbon dioxide for pH adjustment. One advantage of using sulfuric acid is that a loss of sulfuric acid to the atmosphere, which occurs with carbon dioxide, doesn't occur. However, the addition of sulfuric acid causes an increase in the carbon dioxide concentrations by converting bicarbonate to carbon dioxide. This carbon dioxide will subsequently be lost to the atmosphere in an open system causing the pH to rise, just as in the case with the carbon dioxide feed system.

The sulfuric acid would be delivered as a concentrated solution (93%) in 55-gallon drums. The metering pump would pump directly from the drum to a water line where the sulfuric acid would be diluted prior to discharging at the feed point. At the TCE Treatment Facility, sulfuric acid would be fed to the same three locations now receiving carbon dioxide – Reservoirs 1 and 2 and the discharge from the High Lift pumps. The ability to control the feed rate based on the flow rate into the GSF would be provided.

Sulfuric acid is less expensive than carbon dioxide. However, sulfuric acid is more difficult to handle due to its corrosivity and exothermic reaction with water. Carbon dioxide is a safer chemical to handle.

Acid Feed Point Alternatives

In addition to adjusting the pH of the water, adding an acid, such as carbon dioxide or sulfuric acid, also changes the corrosiveness of the water. For the Tower 2 effluent sample collected on August 13, the pH corresponding to a Langlier Index (LI) of 0 is 7.6. (Langlier Index is a tool used to determine the corrosive nature of water. A negative value indicates the water tends to be corrosive and a positive number indicates the water tends to precipitate out calcium carbonate.) Usually, in water supply systems, the goal is to have the LI slightly positive to prevent corrosion. However, if only enough carbon dioxide is fed to adjust the Tower 2 effluent down to about 7.6, it is possible that the pH of the water will exceed 8.0 at the Navy Pond Manhole.

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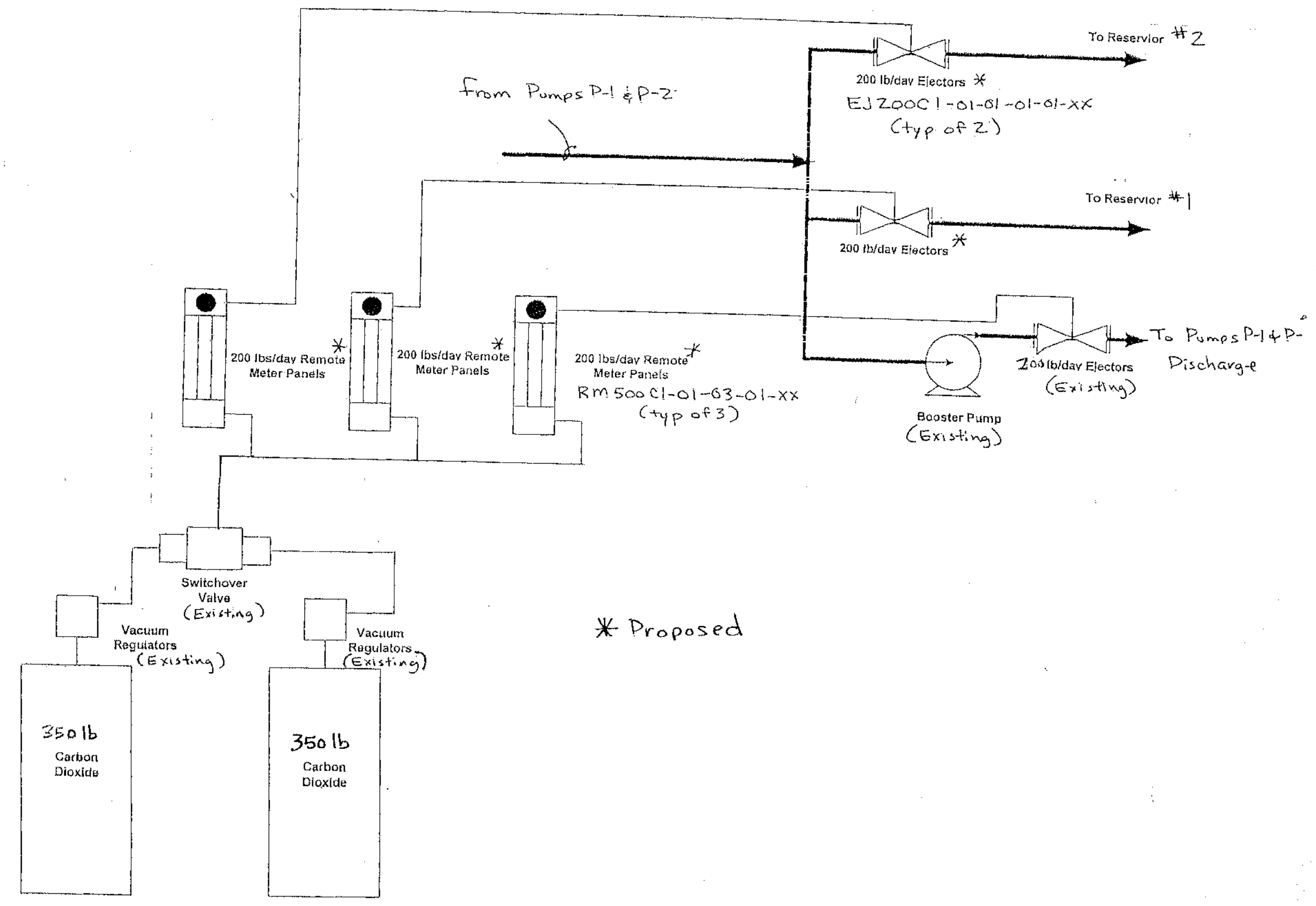


Schematic of Proposed CO_2 System
Figure 3-7

It is recommended that the acid feed rate at the TCE Treatment Facility be limited such that the water does not become corrosive. This would correspond to a pH around 7.6. Corrosiveness of the water can be monitored using a corrosion test loop. An example of one is shown in Figure 3-8. Corrosion coupons are used widely in the power industry. Pre-weighed metal specimens are put in a side stream of the system. After several months, the specimens are removed, weighed, and observed for corrosion. The piping setup could be installed in the line inside the Main Lab.

Addition of acid for pH compliance should occur closer to the river discharge point to reduce the time for carbon dioxide evolution and subsequent pH increase. This acid feed system could be located in the building adjacent to the Navy Pond Manhole. The chemical could be added to the manhole upstream of the Navy Pond Manhole. A sample would be collected at the Navy Pond Manhole to continuously monitor pH and control the acid feed rate. Adding the acid here will adjust the pH in both NCCW systems.

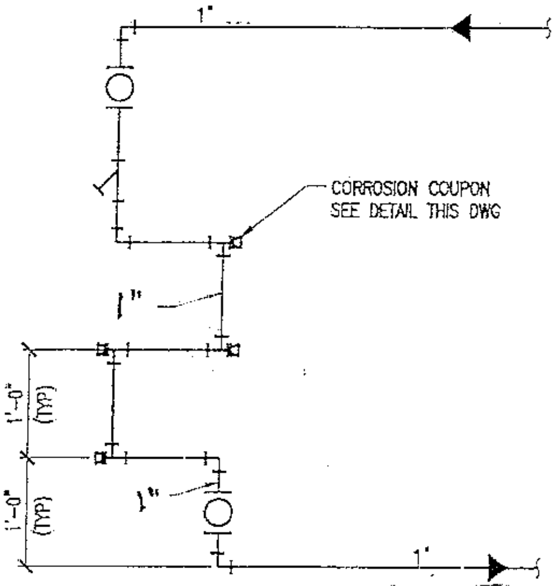
The chemical feed system at the Navy Pond would be similar to that used at the TCE Treatment Facility. If carbon dioxide is used, the maximum feed rate would be 6 mg/L as CO_2. A 200 ppd system would be adequate. If sulfuric acid is used, the capability of feeding 7 mg/L of sulfuric acid is needed.

Recommendations

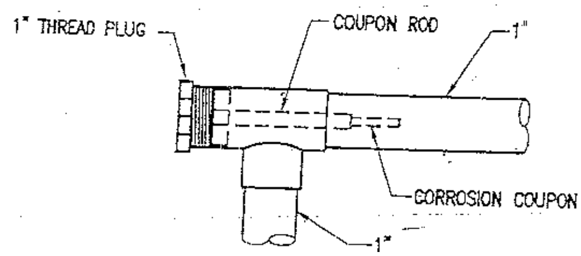
CRREL should come into compliance with its NPDES permit by obtaining a variance form NHDES to raise the pH limit to 9.0. Tests performed by Eastern Analytical indicate this variance should be obtainable. Tests on the NCCW indicate that it will naturally not exceed a pH of 9.0.

CRREL should continue feeding an acid to NCCW System 1 at the TCE Treatment Facility to minimize precipitation of calcium carbonate. Carbon dioxide is recommended instead of sulfuric acid because it is safer and less corrosive. Separate systems should be provided for each of the three feed points.

If the NPDES pH limit is not increased to 9.0, then an acid feed system should be added near the Navy Pond Manhole. Again, carbon dioxide is recommended instead of sulfuric acid because it is easier to feed and less corrosive. Also, the consequence of overfeeding carbon dioxide would be less. This system would include a booster pump and ejector system. Continuous monitoring of pH downstream of the Navy Pond Manhole would be provided. Figure 3-9 shows the recommended system.

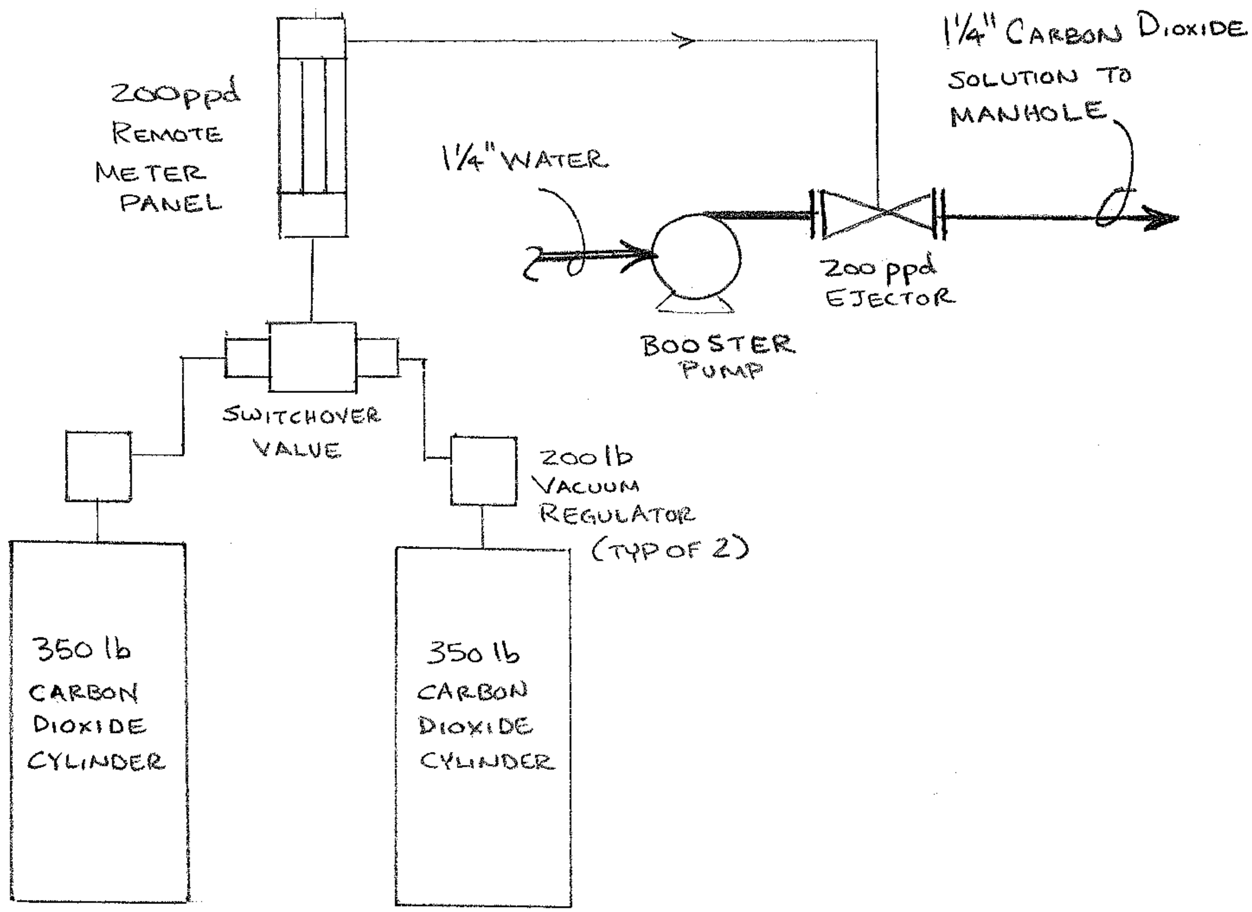


CORROSION TEST LOOP ASSEMBLY
NO SCALE



CORROSION COUPON INSTALLATION DETAIL
NO SCALE

Typical Corrosion Test Loop Assembly
Figure 3-8



Schematic of Proposed CO_2 System at Navy Pond

Figure 3-9

Section 4

Greensand Filter Study

Introduction

Greensand filters are only used for NCCW System 1. Greensand filters (GSF) are used upstream of the air stripping towers to remove iron and manganese. Removal of these two constituents reduces fowling in the strippers and the subsequent noncontact cooling water (NCCW) system. Fowling would be due to formation of iron and manganese oxide solids and, possibly, biological growth of iron bacteria. Because of the concentrations and chemistry, iron is potentially more of a problem than manganese. The NPDES Permit does not limit the iron and manganese concentrations in the discharge to the Connecticut River.

CRREL has stated the following concerns for the greensand filters:

1. Potassium permanganate feed system.
2. Backwashes-frequency, loss of media, and disposal of backwash water.
3. Hydraulic capacity.

In addition to the above issues, the removal rates of iron are discussed. The existing system is evaluated and improvements for the existing GSF are recommended.

Alternatives for dealing with the iron are also presented.

Groundwater Quality

Data on the iron levels in the groundwater is presented in Table 4-1. The groundwater total iron concentrations are generally in the range of 0.3 to 1.1 mg/L. The manganese levels generally vary from 0.05 to 0.13 mg/L. Water analyses by Eastern Analytical, Inc. (EA) in 2007 indicate that about 0.06 to 0.2 mg/L of the total iron is undissolved. This may be due to iron carbonate and/or some oxidation of iron by naturally occurring oxygen in the well water. Also, oxygen may have been introduced to the water samples when they were filtered at the time of sampling. All the manganese is dissolved.

Table 4-1 Iron and Manganese Levels for Wells 1, 2, 4, and 5

Sample Location	Total Iron, mg/L	Dissolved Iron, mg/L	Total Manganese, mg/L	Dissolved Manganese, mg/L	Data Source (see Note 1)
Well 1	0.67 0.22-0.49	0.47 ND	0.13 0.06-0.11	0.14 ND	EA 2007 1995 CD
Well 2	0.33 0.38-0.76	0.27 ND	0.11 0.04-0.12	0.11 ND	EA 2007 1995 CD
Well 4	0.11 0.25-0.87	<0.05 ND	0.022 0.06-0.10	0.023 ND	EA 2007 1995 CD
Well 5	0.39 0.29-0.76	0.29 ND	0.040 0.11-0.13	0.041 ND	EA 2007 1995 CD
GSF Influent (Wells 1,2, & 5)	0.38-0.44	0.32-0.38	ND	ND	EA 2007
GSF Influent (See Note 2)	0.348	<0.10	0.053	0.049	Scaling Inv 1995
GSF Influent (See Note 2)	0.085-1.1	ND	0.03-0.375	ND	CRREL 1993-2007 (See Note 3)

Notes:

1. Data Sources:

   EA 2007 - Eastern Analytical Results for August and September 2007, See Appendix E.

   CRREL 1993-2007 - Data for TCE and GSF Iron and Manganese Levels, See Appendix G.

   Scaling Inv 1995 - Investigation of Scaling In Heat Exchanger System Piping, See Appendix L.

   1995 CD - Excerpt from 1995 TCE Groundwater Treatment Facility Contract Documents, See Appendix M.

2. Which wells were operating is unknown.
3. There were a few results that seemed suspect due to their extreme values and are not included in this table.

ND - not determined

Source: Stanley Consultants, Inc.

Existing GSF System

The GSF system is shown in Figure 4-1.

The GSF system oxidizes and filters out iron and manganese. The greensand in the filters is produced by treating glauconite (greensand) with manganous sulfate and potassium permanganate to produce an active supply of manganese dioxides on the sand grains. The manganese dioxide removes soluble iron and manganese. A bed of anthracite filter media on top of the greensand reduces the plugging of the greensand.

CRREL has two 10-foot diameter pressure GSF. Originally the filters had 21 inches of anthracite on top of 24 inches of greensand. The media was on top of 16 inches of support gravel. In February 2003 Monarch replaced the anthracite and greensand in the filters. At that time Monarch noted that there was no anthracite coal left in the filters. Apparently media was being lost during backwashing. The backwash system is discussed further later.

Addition of potassium permanganate to the GSF influent oxidizes iron and manganese thereby reducing the load on the GSF and also helps to continuously regenerate the filter. At the time of this study, potassium permanganate was not being fed due to problems with the pumps. CRREL is in the process of replacing the pumps and some associated piping.

Potassium permanganate is delivered to CRREL as a solid. Normally it is manually mixed with water to form a 0.6 percent solution. One of two positive displacement pumps feed the potassium permanganate solution to the GSF influent upstream of an inline mixer. The feed rate is automatically paced by a flow signal from the GSF influent flow meter.

The potassium permanganate system is discussed further later.

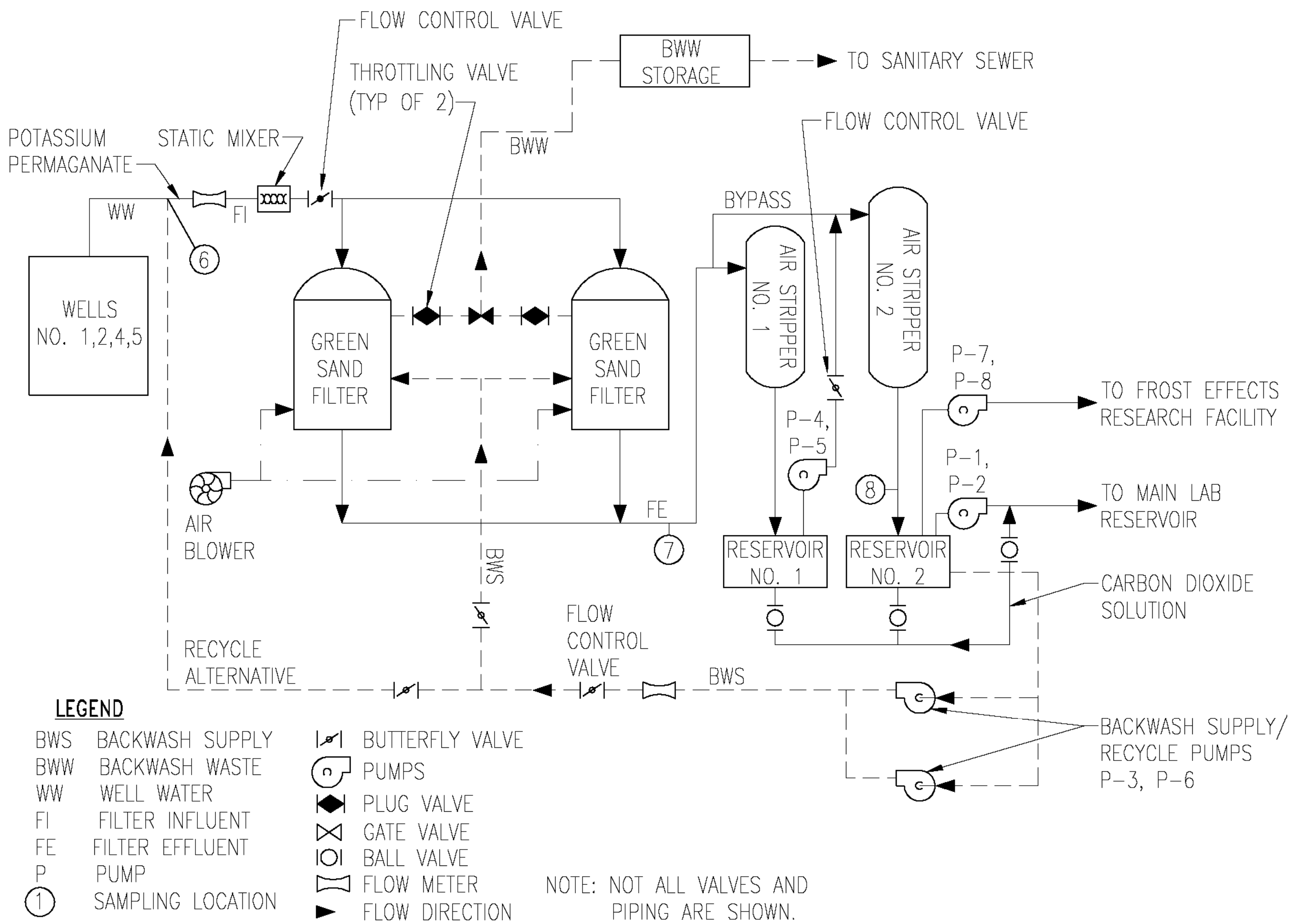
Evaluation of GSF System

Greensand filters with potassium permanganate addition is a common way to remove iron and manganese. It is considered one of the least expensive and easiest processes for iron and manganese removal.

Removal Rates of Iron and Manganese

Since the purpose of the GSF is to remove iron and manganese, the water quality data was evaluated to determine how well the GSF meet this objective. Normally, GSF can be expected to reduce the iron concentration to 0.2 mg/L and the manganese reduction will be about 50 percent. Iron is easier to remove than manganese

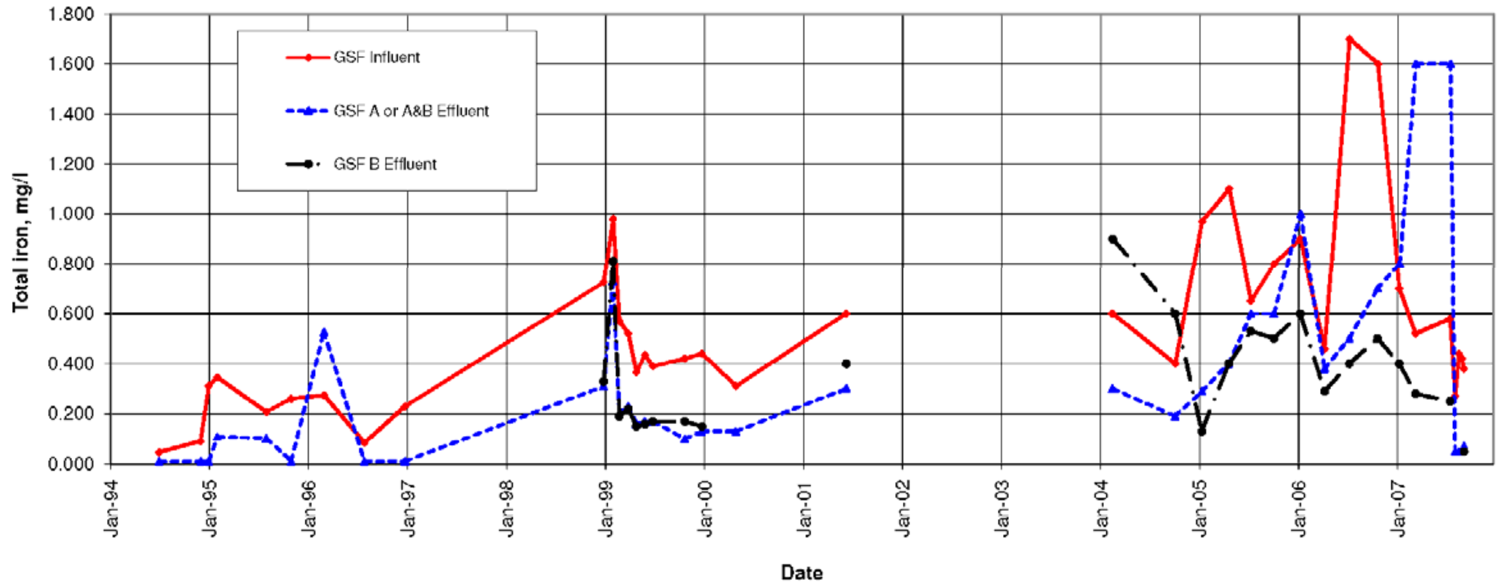
The iron and manganese levels for the GSF are shown in Figure 4-2 and Figure 4-3 for the time period 1994 - early 2007. These results indicate that iron removal has varied considerably.



Schematic of CRREL TCE Treatment System

Figure 4-1

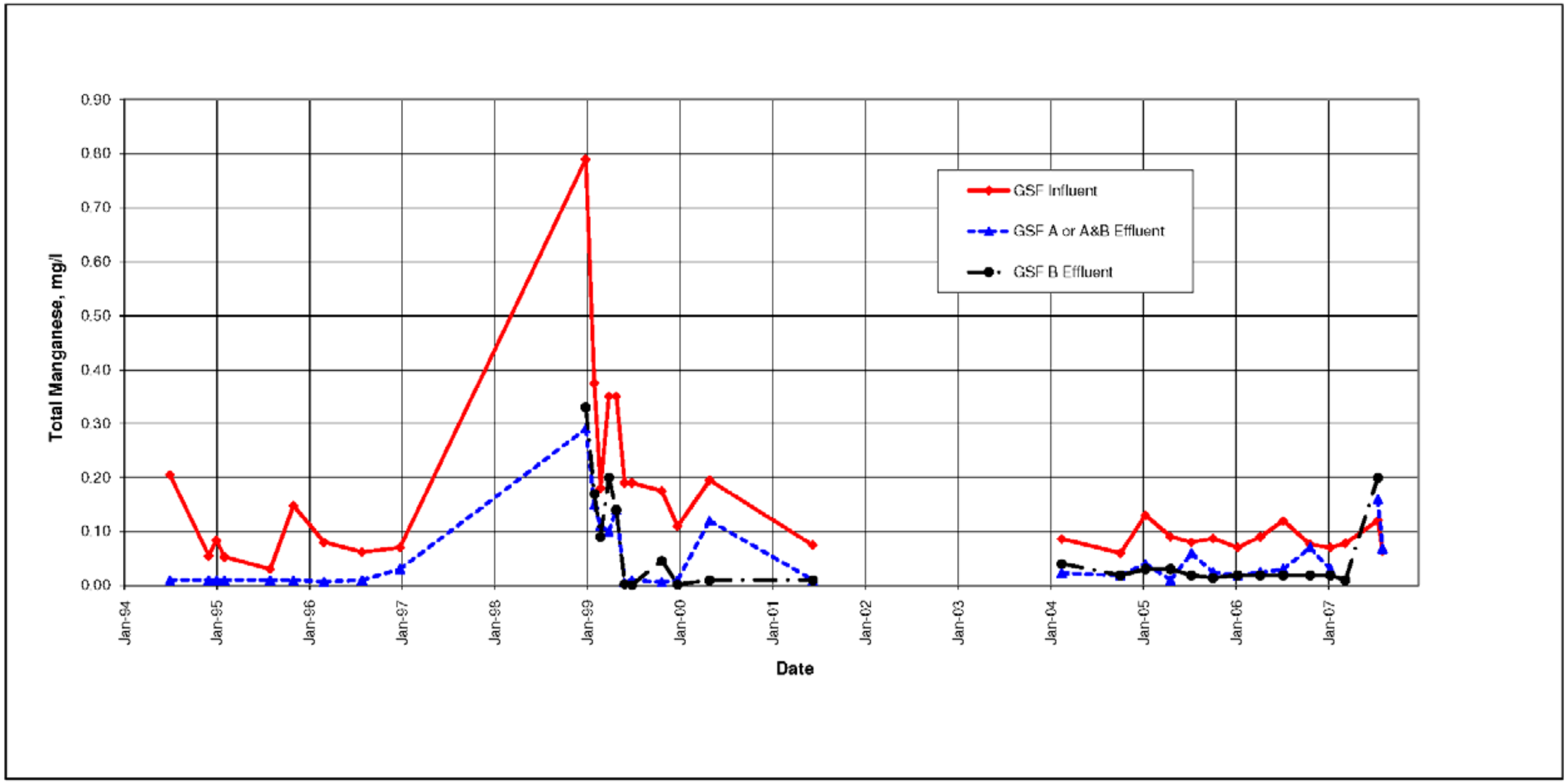
Stanley Consultants INC.



Iron Levels for CRREL Greensand Filters

Figure 4-2

Stanley Consultants INC.



Manganese Levels for CRREL Greensand Filters

Figure 4-3

The wide range in results could be due to one or more of the following reasons:

1. Complexing of iron and manganese with other chemicals in the water. GSF do not operate well when total organic carbon (TOC) values are greater than 1 mg/L. The only data that indicates the TOC levels may be greater than 1 mg/L in the groundwater was the design criteria table included in the 1995 Contract Documents. This table indicated a TOC range of 2 to 3 mg/L. However, all other tests, including the recent tests by EA indicate TOC values of less than 1 mg/L. EA also tested for organically bound iron and the result was negative.
2. Inadequate feed rate of potassium permanganate. Even though the feed rate of potassium permanganate is paced off the GSF influent rate, the demand for potassium permanganate varies also with the actual level of iron and manganese and other constituents in the groundwater. Data indicates that the iron and manganese levels vary for the four wells used. Also, during the Monarch visit in 2003 they noted that insufficient potassium permanganate was being fed.
3. Loss of effectiveness of the greensand in the filters. If the potassium permanganate feed rate is too low, the greensand eventually looses its effectiveness. The greensand has most likely lost its effectiveness because potassium permanganate has not been fed for several months. Monarch, the GSF supplier, indicates the greensand can be regenerated by saturating for eight hours with potassium permanganate. Afterwards the bed should be aerated and backwashed.
4. Loss of media in the filters. Less media results in lower filtration capacity of the filters. As stated earlier, a visit by Monarch in 2003 determined that all the anthracite coal was gone. Monarch recommended improvements to reduce media loss in the future. Those improvements have not been made. CRREL has observed substantial media in the backwash water since the media was totally replaced in 2003. This media should be replaced if CRREL decides to continue using the GSF process. Also, the recommendations by Monarch to reduce the air flow rate during backwashing should be adopted. The air flow rate could be changed by using a different sleeve and pulley ratio or, even better, by adding a variable frequency drive (VFD) on the blower such that the air flow rate could be changed gradually.
5. Inadequate backwashing. If the media is inadequately cleaned, breakthrough of iron and manganese can occur. Also, if the time between backwashes it too great breakthrough of iron and manganese occurs. There is no evidence that the media is not being cleaned adequately. Physically looking at the media would help determine the adequacy of the backwashes. Also, looking at the turbidity level in the GSF effluent with time would help determine if the backwash is adequate or if more frequent backwashes are needed.
6. Corrosion. The groundwater tends to be corrosive as indicated by its negative Langelier Index (LI). (Langlier Index is a tool used to determine the corrosive nature of water. A negative value indicates the water tends to be corrosive and a positive number indicates the water tends to precipitate out calcium carbonate.) The LI for the GSF influent sample collected on August 13th was –0.4. Some corrosion products may be sloughing off into the filter effluent. The best way to determine if the water is corrosive is to install a corrosion coupon. The corrosion coupon was discussed in Section 3.

The results for iron levels across the GSF for samples collected in August and September of 2007 are presented below. Note that the Tower 1 Influent is equivalent to the GSF Effluent.

Table 4-2 Iron Levels Across GSF

Sample Date	Total Iron, mg/L GSF Influent	Total Iron, mg/L GSF Effluent
8-13-07	0.27	<0.05
8-27-07	0.44	<0.05
9-7-07	0.42	0.05
9-14-07	0.38	0.06
Detection Limit is 0.05 mg/L.		

Source: Eastern Analytical, Inc.

These recent results indicate essentially complete removal of iron across the GSF despite the lack of feeding of potassium permanganate. Manganese results indicated no removal. It appears that a biological filter has formed in the GSFs.

Biological filters are discussed later in this section.

Potassium Permanganate System

Potassium permanganate is an oxidant. Iron and manganese are oxidized by potassium permanganate to form insoluble solids. Also the potassium permanganate continuously regenerates the greensand in the filters. Potassium permanganate is corrosive and requires special handling.

Potassium permanganate feed rates are generally:

0.94 milligrams (mg) of potassium permanganate per mg of iron, and

1.92 mg of potassium permanganate per mg of manganese.

Using these values, the raw water quality data, and the well pumping volumes for 2006, the potassium permanganate feed rate should be 1.7 to 13 lb/day. Potassium permanganate is usually fed as a 1 percent solution. (A 2 percent solution is considered maximum.) Thus, the solution pumping rate desired is 0.85 to 6.5 gph of a 1 percent solution. The average demand of potassium permanganate is estimated at 3.5 pounds per day.

CRREL has two feed pumps with one serving as a standby. Each is sized to feed 0.3 to 6.0 gph, which is adequate. (A slightly higher concentration of 1 percent solution could be used to meet the maximum demands.) CRREL indicates they prepare a 0.6 percent solution, which is acceptable. Their normal usage rate is about 5 pounds per day. Based on the above analysis, this may be too high.

CRREL personnel should check the color in the GSF influent and effluent daily to assure proper potassium permanganate feed rate. There should only be a slight pink color in the GSF influent and no color in the GSF effluent.

CRREL should flush the potassium permanganate system with water when feeding of potassium permanganate is discontinued for any extended period of time.

Backwashing

Each filter is backwashed twice a week based on a time basis. Normally GSF are backwashed every 24-48 hours. Thus the time between CRREL backwashes is longer than normally used. Apparently the headloss across the filter does not become too excessive during the filtration cycle since the flow rates to the air stripping towers remain adequate. Tests on the GSF effluent at various times of the filtration cycle could determine if iron and manganese are breaking through near the termination of the filtration cycle. These tests would determine if the time between backwashes should be changed.

The automatic backwash sequence is manually initiated. The sequence of the backwash cycle is presented below. The total time to backwash is approximately 21 minutes.

Table 4-3 Backwash Sequence

Event	Duration, min
Partially drain filter	2
Air scour only	10
Backwash with water only (about 720 gpm)	7
Rinse (Filter-to-Waste)	2

Source: CRREL

The flowmeter on the backwash supply line indicates that the current backwash rate is constant at about 720 gpm.

Media losses have been occurring for years from the filters during backwashing. During a site visit in July, anthracite and small pebbles that had backwashed from the filters were observed. Probable reasons for media loss are:

1. Backwash and/or air wash rates are too high. Some sources indicate backwash rates should be about 12 gallons per minute per square foot (gpm/ft2). Currently, CRREL is backwashing at about 9.2 gpm/ft2, which may not be adequate to clean the media. CRREL should observe the turbidity in the filtered water after a backwash cycle to help determine if the backwash rate was adequate. Air wash rates were discussed earlier in this section.
2. A closed valve has been installed on the air release on the top of tank. Sometimes the air relief valve on the top of the tank leaks water and then is replaced with an open/close valve. This doesn’t allow for air relief anymore. Whether the air relief valve has been eliminated on CRREL’s filters is unknown.
3. Bring the backwash rate up slowly over 1.5 to 2 minutes. Currently CRREL backwashes at a constant rate throughout the backwash. If the backwash rate isn’t

ramped up the media tends to lift as a unit when initiating the backwash possibly causing some media loss.

As indicated above under "Removal Rates of Iron and Manganese" the following modifications are recommended in the backwash system to reduce media loss and to monitor backwash performance:

- Modify air blower to reduce air scour rate.
- Ramp up air scour rate.
- Ramp up water wash rate.
- Periodically check the filter effluent turbidity at the beginning and end of a filtration cycle to determine if backwash practice is adequate.

Since 2006 the backwash wastewater has been sent to a temporary holding tank and then gradually discharged to the City of Hanover's sanitary sewer. This was done because the high solids loading exceeded NPDES permit requirements. No improvements are recommended for this disposal method.

Hydraulic Capacity

CRREL indicates that occasionally the hydraulic demands for the NCCW System 1 cannot be met. CRREL desires to increase the capacity of the GSF system to match the hydraulic capacity of the air stripping towers, which is 850 gpm, such that more water is available for NCCW System 1. The treated water is always used to feed the NCCW System 1 and, occasionally, the Frost Effects Research Facility (FERF). How much is currently needed for each is unknown.

Possible reasons for not having sufficient capacity include:

- System Design Capacity - The system was sized too small.
- Element Design Capacities - Element(s) in the system cannot reach design capacities.
- Controls - Controls for how various elements functions limit quantity of water being conveyed.
- Backwash Water Demands - During the backwashing of the GSF, there is insufficient water for the NCCW System 1.

System Design Capacity. According to the design capacities of the various elements of the TCE treatment facility as supplied by CRREL (see Table 1-1, Figure 1-1, and table below), the High Lift Pumps and the Main Lab Reservoir Pumps limit the capacity of the NCCW System No. 1 to 500 gpm. The maximum capacity of the pumps feeding FERF is 200 gpm. Thus the total capacity currently needed by the GSF is 700 gpm plus additional capacity a few hours per day to help replenish the backwash water supply.

Table 4-4 Design Capacities of TCE Treatment Facility and NCCW System 1 Elements

Element	Design Capacity, gpm
Wells 1, 2, 4, and 5	total: approximately 1500 gpm; head capacity unknown (See Tables 1-2)
GSFs	Between backwashes: 800 gpm During backwash: 400 gpm
Air strippers	850 gpm
Low Lift Pumps, P-4 and P-5	800 gpm, each
High Lift Pumps, P-1 and P-2	500 gpm, each
Main Lab Reservoir Pumps	Number-2 Floway pumps, Size DKL, 500 gpm, 10 hp
Note: Each set of pumps includes one standby pump.	

Source: CRREL

Increasing the design capacity of the NCCW System 1 to more than 500 gpm requires at least replacement or addition of High Lift Pumps and Main Lab Reservoir Pumps. Depending on the demand for the FERF, capacities of other elements may also need to be increased.

Element Design Capacities. The scope of this report only addresses whether the GSF are achieving their design capacity. Other elements, such as the pumps, may not be performing at their design capacity. Evaluation of these elements is not included in the scope of this study.

According to the 1995 Contract Documents, the GSF were originally designed to provide 500 gpm to the Main Lab Reservoir and, during several months per year, 250 gpm to the Frost Effects Research Facility (FERF). (Note that Table 1-1 indicates capacity of Pumps P-7 and P-8, which feed FERF, is only 200 gpm each.) The documents also indicate that the total GSF flow rate would be increased by 50 gpm several hours per day to replenish water used for backwashing. Thus the GSF were designed to each handle between 250 and 400 gpm, which translates to 3.2 to 5.1 gallons per minute per square foot (gpm/ft2). The higher capacity desired by CRREL, 850 gpm, corresponds to 5.4 gpm/ft2.

The well usage data for 2006 and 2007 indicates the maximum flowrate through the GSF for this time period was 690 gpm. There is no indication that the GSF could not hydraulicly handle more flow. From the well pump information, it appears that more flow could be pumped through the GSF. However, at higher flow rates, the possibility of solids breakthrough becomes greater.

The GSF were originally designed to handle 5 gpm/ft2. Monarch, the supplier of the GSF, indicates that GSF should operate well at 5 gpm/ft2 and at possibly higher loadings. Some systems operate fine at 7 gpm/ft2. Design handbooks indicate GSF operate well at about 4 gpm/ft2, but this limit is for water supply systems which have more stringent requirements on effluent quality than a nonpotable water system such as CRREL’s.

In order to determine whether the GSF at CRREL can handle a higher hydraulic loading, CRREL should measure the turbidity in the GSF effluent at higher filtration rates.

Controls. Another potential problem in supplying water to the NCCW System 1, are the controls for the various sets of pumps. (Refer to Figures 1-1 and 1-2.) The controls description below was taken from the 1995 Contract Documents. It is unknown whether this control system is still utilized.

> **Wells.** Which of the wells will operate is manually selected. Normally the operator inputs a desired flow rate, which controls the position of a throttling valve on the influent line to the GSF. This rate is maintained unless the level in Reservoir 1 becomes too low or high. Then the influent flow control valve is adjusted accordingly to maintain the appropriate Reservoir 1 level. The wells automatically shut off if a high-high level is reached in Reservoir 1. Proper operation would be such that the wells would never shut off unless manually selected to.
>
> **Low Lift Pumps (P-4 and P-5).** These pumps normally operate all the time. A throttling valve on the pump discharge controls their pumping rate. The valve is throttled based on the water level in Reservoir 2. The pumps automatically shut off if a low level is reached in Reservoir 1 or a high level in Reservoir 2.
>
> **High Lift Pumps (P-1 and P-2)**. The High Lift Pumps are controlled by the water level in the Main Lab Reservoir. When there is a high level in the Main Lab Reservoir, the pumps shut off. The pumps turn back on when a low level is reached in the Main Lab Reservoir. When an extreme low level is reached in Reservoir 2, the High Lift Pumps are automatically stopped.
>
> This operation scenario, with the High Lift Pumps turning on and off, has a domino effect on the Low Lift Pumps and well pumps causing water levels in Reservoirs 1 and 2 to reach extremes, pumps to turn on and off, and discontinuous flow through the treatment processes. One possible solution is to install VFDs on the High Lift Pumps that are controlled by the water level in the Main Lab Reservoir. This would allow the high lift pumps to operate continuously, thus maintaining less fluctuating demands on upstream pumps.

Backwash Water Demands. The other hydraulic concern is the backwash water demands for the GSFs.

The backwash water supply is from Reservoir 2. Reservoir 2 has a capacity of about 20,000 gallons. The amount of water used from Reservoir 2 for backwashing during the 21 minute cycle is 5,100 gallons (backwash rate of 730 gpm for 7 minutes). If the flow rate to the online GSF is 400 gpm, as designed, and Reservoirs 1 and 2 are nearly full at the beginning of the backwash cycle, the feed rate of 500 gpm can be maintained to the Main Lab Reservoir during backwashing. However, for ease of operation, it is recommended that the High Lift Pumps do not operate while the Backwash Supply Pumps are operating. If the level in the Main Lab Reservoir is high at the start of the backwash cycle, service to the Main Lab would not be interrupted.

After each backwash cycle, the filtration rate through the GSF should be increased to a higher rate than the total flow rate leaving Reservoir 2 such that the levels in Reservoirs 1 and 2 could be returned. If the filtration rate is increased by 50 gpm, the levels could be revived within 3 hours.

Further analysis of CRREL's control system during backwashing would determine what, if any, modifications should be made to achieve the uninterrupted service during backwashing.

Alternative Iron Handling Methods

Alternatives for handling the iron in the NCCW System 1are presented in Table 4-5. Alternatives considered are to not treat for iron (Do Nothing), three iron removal methods (GSF, ion exchange, and biological filters), and sequestering. These alternatives are described below.

Table 4-5 Summary of Alternatives for Handling Iron

Alternative	Description	Pros	Cons	Costs
Do Nothing	Provide no treatment of iron; bypass GSF	No longer need to handle backwash water or chemical feed systems	Will increase the fouling rate in the towers	Capital: None Operational: Additional costs to replace/clean packing material in towers
GSF	Make improvements to GSF—Replace media, modify blowers, modify backwash controls	CRREL familiar with process Obtain partial removal of iron and manganese	Continued handling of corrosive potassium permanganate Continued discharge of backwash wastewater Removal rates of Fe and Mn not great	Capital – Media Replacement: Anthracite-$10,000 Greensand-$36,000 Modifications to blowers-$20,000 PP costs- $4,200 per year
Ion Exchange	Treat 50% of the water to remove Fe and Ca and blend with untreated water	Also removes calcium thus reducing fouling rate of strippers	Very costly May foul Regeneration volumes are great-21,600 gpd	Material Capital Cost-$190,000 Salt costs-$31,000 per year
Biological Filters	Iron is removed by bacteria in the existing GSF	Removal rates of Fe are good Filtration rates higher than for GSF No chemical feed systems required	No removal of Mn in single stage system System may be sensitive to sudden changes in flow or temperature Continued discharge of backwash wastewater to City Sewer	Possibly media replacement/addition Modifications to blowers - $20,000

Table 4-5 Summary of Alternatives for Handling Iron (Continued)

Sequestering	Sequestering agent added to reduce iron and calcium precipitation	Treats Fe and Ca thereby reducing fouling rate of strippers	Requires chemical feed systems: sequestering, and possibly chlorination, and dechlorination Foaming may occur in Towers	Capital cost for Jaeger sequestering system- \$8,000 Jaeger's JP-7 annual chemical cost- \$18,000

Note:

1. Cost estimates presented are Stanley Consultants' opinions of probable project and construction costs. Costs estimates are made based on Stanley Consultants' experience and best judgment. The construction costs are based on current prices. The estimates do not include inflation. Stanley Consultants has no control over cost of labor, materials, equipment, contractor's methods, or competitive bidding or market conditions. Therefore, Stanley Consultants does not guarantee that actual construction costs will not vary from cost estimates presented.
2. Ca-calcium, Fe-iron, Mn-manganese, PP – Potassium Permanganate

Source: Stanley Consultants, Inc.

Do Nothing

The "Do Nothing Alternative" would provide no treatment for iron. If all the iron was consequently deposited in the Towers, this would result in over 1700 pounds of iron hydroxide solids accumulating in the towers each year. This would require more frequent cleaning or replacement of tower packing material. However, there would be no capital or operational costs associated with iron treatment.

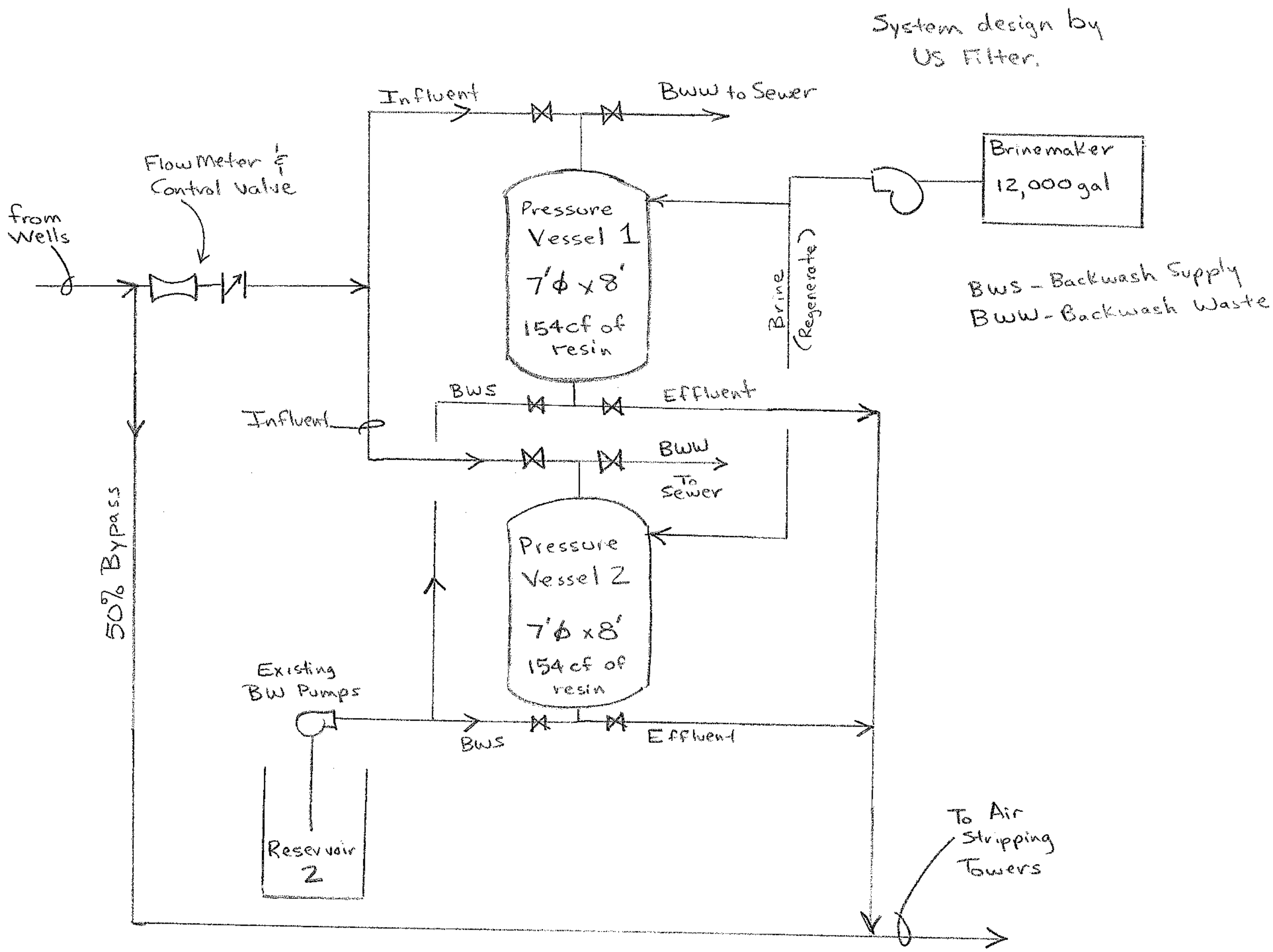
Greensand Filters

A common iron treatment method is oxidation followed by filtration, such as in the existing GSF system. Common oxidants are oxygen, chlorine, and potassium permanganate. Iron and manganese reaction rates with oxygen are slow. Chlorine reacts quickly with iron but at a much slower rate with manganese. Potassium permanganate reacts quickly with both iron and manganese over a large pH range. The recommended oxidant for CRREL would be permanganate because of its reaction rate and also because it is easier to handle than chlorine. Greensand filters have already been described under the description of the existing system. However, as seen with the existing system, oxidation and filtration will not remove all the iron and some subsequent deposition in the air strippers and downstream systems is expected.

Ion Exchange

Figure 4-4 shows an ion exchange system as developed by US Filter for CRREL. Initial calculations indicate 50% of the total flow should be treated and then blended with bypassed water to form a stable water.

Ion exchange for removal of iron consists of using a cation resin. Sodium is commonly used on the resin. As the water flows through the tank, the iron and other cations in the water, replace the sodium on the resin. When the resin has been exhausted, the unit is removed from service and regenerated with a solution of sodium chloride. The waste regenerate contains the iron and other chemicals removed. Even though the primary goal in this study is iron removal, ion exchange would also provide the advantage of removal of calcium.



Ion Exchange System

Figure 4-4

The cost for ion exchange is very high. Organics and iron precipitates can foul the media easily. The data from EA indicate that there are some iron precipitates in the raw groundwater. If this alternative is selected, pilot testing should be performed.

Biological Removal

Biological removal of iron involves filtering the water through media that contains iron bacteria. The bacteria oxidizes the iron from ferrous (Fe^{2+}) to ferric (Fe^{3+}) and accumulate a metal precipitate. This process is used extensively in Europe but has been used to a lesser extent in the US. Infilco-Degremont, a manufacturer of water treatment equipment, provides a biological filter for iron and manganese removal. Their process is called Ferazur/Mangazur. Their experience is that the biological filter works down to a temperature of about 5°C. Filtration rates can be as high as 20 gpm/ft^2. Other sources indicate biological filters operate successfully at loading rates of 5-15 gpm/ft^2, which is higher than rates for GSF, and iron and manganese removal rates are better than for GSF. However, almost always, to have manganese removal, two filters must operate in series with the first filter removing iron and the second, manganese.

Backwashing of biological filters usually includes air scour, low-rate backwash at 4-6 gpm/ft^2, and high rate backwash at 10-12 gpm/ft^2. Total backwash duration is typically 5-10 minutes. Times between backwashes are typically 1-3 days.

As discussed earlier during this study, feeding of potassium permanganate has not occurred for several months and currently is not being fed. However, iron was almost completely removed across the filters. It appears that a biological filter has inadvertently been formed. A backwash sample collected this month tested positive for the presence of iron bacteria. Naturally-occurring iron bacteria probably seeded the filter media. Since potassium permanganate was not added, the bacteria were not killed. However, the biological filters are not currently removing manganese, which is consistent with how single stage biological filters typically operate.

Water temperature may be a problem for the iron bacteria. It is unknown how cold the groundwater can get but groundwater temperatures do not usually vary much seasonally. The water temperature for the groundwater sample collected in January 1993 indicated a temperature of 9.3°C (see Appendix L). The GSF influent water temperature for the samples collected in August and September were 10-13°C.

Another operational consideration is that it is best to have continuous flow through the biological filter (except during backwashes) and not to have sudden changes in filtration rates. Iron bacteria need oxygen. Even though air is not added to the GSF influent, there may be naturally occurring air in the water. Too much oxygen is not good since then the iron would be oxidized. Iron bacteria use iron in its reduced form.

Currently there probably is only about 24 inches of greensand in the filters. Manganese greensand has an effective size of 0.30 to 0.35 millimeters (mm). Typically biological filters have 36 to 60 inches of media with an effective size of 1.0 to 1.5 mm. However, apparently the unconventional media is working adequately.

Sequestering

An alternative to iron removal is sequestering the iron such that it doesn't precipitate out. Jaeger, the manufacturer of the packing material used in the air stripping towers, provides a sequestering package that utilizes the sequestering agent JP-7 (see Appendix N.). JP-7 sequesters soluble iron, manganese, calcium, magnesium and silica. It also produces a microscopic film to decrease corrosion rates. Even though this product contains phosphate, Jaeger claims that biological growth would not be a problem. Jaeger's system includes a 10 gpd feed pump, which would feed directly out of a 55-gallon drum. Feed rate would be about 6 gallons per day. The sequestering agent JP-7 costs $9 per gallon (not including shipping).

If biological growth would occur, a disinfectant would need to be added. The disinfectant would probably be hypochlorite because of its relative ease of use, low cost, and ability to maintain a residual. Dechlorination would also be needed since the NPDES permit would undoubtedly include a maximum chlorine residual in the discharge to Connecticut River. (The City of Hanover has a maximum chlorine residual limit of 1.0 mg/L, but indicated that this limit varies greatly for dischargers along the river.) Dechlorination would probably be provided by sodium bisulfite and occur at the Navy Pond Manhole. Because of the expense and maintenance concerns with 3 chemical feed systems, sequestering would not be an attractive option should biological activity increase due to the feeding of the sequestering agent.

Sequestering agents may also cause foaming in the air strippers.

Because of the several concerns with feeding a sequestering agent and because there are several sequestering agents available, bench scale tests of the sequestering agents would be needed prior to implementation of this alternative.

Discussion and Recommendations

Iron is removed to minimize iron deposits and biological growth in the air strippers and subsequent NCCW.

The packing material in the two air strippers was removed within the last year after being in service for over 12 years. Monarch performed the work at a cost of $50,885. A picture of the packing material removed is shown in Figure 4-5. From the color, it is apparent that iron and/or manganese were present. However, tests by Monarch indicate the predominant precipitate was calcium carbonate. Also, Monarch noted that there was only limited biological growth, which occurred in the first few inches at the distributor. The addition of potassium permanganate to the well water probably reduced the biological activity. Plus some iron and manganese removal occurred in the GSFs.

Thus, even if iron is removed, CRREL can still expect solids deposition in the packing material unless the water is softened (calcium reduction) prior to the air strippers. Monarch indicated that instead of total packing material replacement, in-place acid cleaning of the packing media could probably be done biannually. Monarch's cost to perform the cleaning and dispose of the spent cleaning material would be about $10,000 per cleaning. Initially piping modifications would need to be made at the towers to facilitate circulation of the cleaning solution.

Stanley Consultants INC.

Air Stripping Tower Packing Material Removed

Figure 4-5

To reduce the rate of fouling of the air stripping towers and subsequent NCCW system it is recommended that CRREL continue to use the “GSF” as biological filters. The biological filters are simple to operate and require no chemical feed systems. The filtration rate can probably be increased such that CRREL’s goal of 850 gpm through the filters could be achieved. The increased rate may require more media though. The modifications to the air and water backwash systems recommended for the GSF should be adopted for the biological filters. Iron removal rates and turbidity breakthrough should be monitored to determine if backwash practices are adequate.

Elimination of the potassium permanganate system should be delayed at least one year to assure adequate performance by the biological filters.

At this time the use of a sequestering system is not recommended unless it is desired to reduce precipitation of calcium carbonate in the air stripping towers. The current packing material replacement rate of 12 years is considered good by industry standards.

Controls for how the pumps (wells, Low Lift, and High Lift) operate normally and during backwashes should be evaluated such that supply to NCCW System 1 will not be interrupted.

Appendix A

Existing Equipment Data

PULSA® Series

BID SPECIFICATION

DATA SHEETS BAU/H-916-1

Pulsafeeder
77 Ridgeland Rd.
Rochester, New York 14623
716-292-8000 Fax 716-424-5619

CUSTOMER	DATE	MODEL NO	QUANTITY	PAGE
		680 HSE	2	OF

ADDRESS: Hanover NH

CUSTOMER ITEM:

QUOTE REFERENCE:

JOB CONDITIONS

PRODUCT: Potassium Permanganate — PUMPING TEMPERATURE: ☐ °C ☐ °F

SPECIFIC GRAVITY — VISCOSITY @ PUMPING TEMP. ☐ CPS ☐ SSU ☐ OTHER

VAPOR PRESSURE @ PUMPING TEMPERATURE ☐ PSIA ☐ PSIG ☐ BARS ☐ kPa ☐ OTHER

FLOW, MAX. 4.0 — FLOW, MIN. ☒ GPH ☐ GPM ☐ LPH ☐ OTHER

OPERATING PRESS. (1) (MAX) 60 — SUCTION PRESS. (2) ☐ PSIA ☒ PSIG ☐ BARS ☐ kPa ☐ OTHER

SOLID CONCENTRATION % ☐ WEIGHT ☐ VOLUME

SOLID SIZE ☐ MESH ☐ MICRONS ☐ INCHES ☐ OTHER

(1) MUST BE AT LEAST 5 PSI ABOVE SUCTION PRESSURE — (2) MUST BE AT LEAST 9.5 PSIA AND 5 PSI ABOVE VAPOR PRESSURE

COMMENTS

SPECS

RATED CAPACITY 6.0 ☒ GPH ☐ GPM ☐ OTHER — PUMP ASSEMBLY NO.

RATED PRESSURE 300 ☒ PSIG ☐ OTHER — MULTIPLEX HEAD

HYD. BY-PASS VALVE SETTING 66 ☒ PSIG ☐ OTHER — PISTON SIZE, DIAM. 0.875" INCHES

VALVE TYPE Ball — STROKE LENGTH 0.500 INCHES

SUCTION VALVE QTY. 1 SIZE 1/2 INCHES — STROKE RATE 88 SPM

DISCHARGE VALVE QTY. 1 SIZE 1/2 INCHES — GEAR RATIO 20:1

CONNECTION SIZE: SUCTION 1/2 DISCHARGE ☒ INCHES ☒ NPT ☐ FLANGED ☐ OTHER

MATL'S

VALVE 316 Stn Stl — VALVE & CAP GASKETS PTFE — REAGENT HEAD D. I. Tubular

VALVE SEAT 316 Stn Stl — DIAPHRAGM GASKETS N/A — DIAPHRAGM Hypalon

VALVE CAP & GUIDE 316 Stn Stl — INTERMEDIATE FLUID Ethylene Glycol and Water

HYDROSTATIC TEST ☐ YES ☒ NO — WITNESSED TEST ☐ YES ☒ NO — CALIBRATION TEST ☐ YES ☒ NO — INSPECTION ☐ YES ☒ NO

OTHER — REMOTE HEAD — LEAK DETECTION

OTHER

All pumps receive a dynamic performance test for rated capacity/pressure test prior to shipment.

For Standby Spares Kit, Order KOPKIT: [illegible]

CONTROL DETAILS

DRIVER DETAILS

HP 1/4 — VOLTS 90 V PM — HZ — PHASE — AC — DC X

RPM — FRAME — MFG

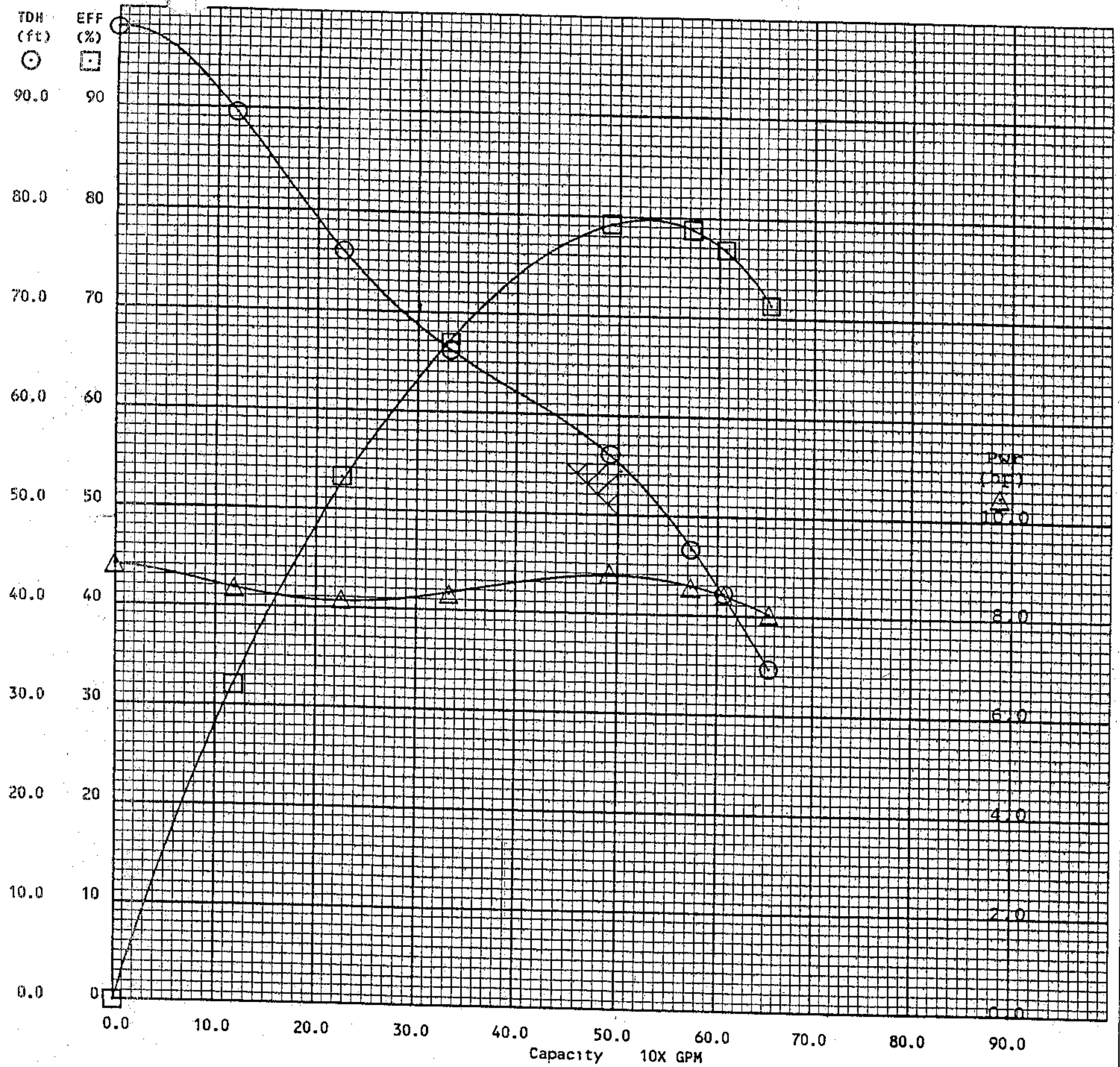
ENCLOSURE: TEFC — MINIMUM SERVICE FACTOR IS EQUAL TO 1.0

DRAWING REFERENCE: DIMENSIONAL DRAWING # ____ CROSS SECTION DWG # ____ CATALOG # ____

PUMP SPARES:

Qty	Description	Part No.
2 -	Tubular Diaphragm	W094136-HYP
2 -	Flat Diaphragm	W094392-NTR
4 -	Valve Ball 316 S/S	W041935-316
4 -	Valve Seat 316 S/S	W202906-316
4 -	Gaskets	W096477-000
12 -	"O" Rings	W078200-TFE

P-1/2 (Main Lab)



DRESSER PUMP DIVISION
DRESSER INDUSTRIES INC.
PUMP TEST DATA

RPM	GPM	TDH	BHP	EFF
1771.0	751.5	130.5	31.3	79.2
1772.0	874.7	108.6	30.5	78.7
1772.0	926.8	98.2	29.9	76.8
1773.0	998.9	80.9	28.6	71.3
1771.0	508.0	154.0	29.6	66.8
1772.0	345.1	177.1	29.1	53.1
1771.0	180.2	208.5	29.7	32.0
1769.0	0.0	227.4	31.2	0.0

I CERTIFY THAT WITHIN THE ACCURACY OF TEST INSTRUMENTATION THIS TEST REPRESENTS THE PERFORMANCE OF 10NKL-4 PUMP #93-70-101067-1

James Bird

SP.GR.:1.0

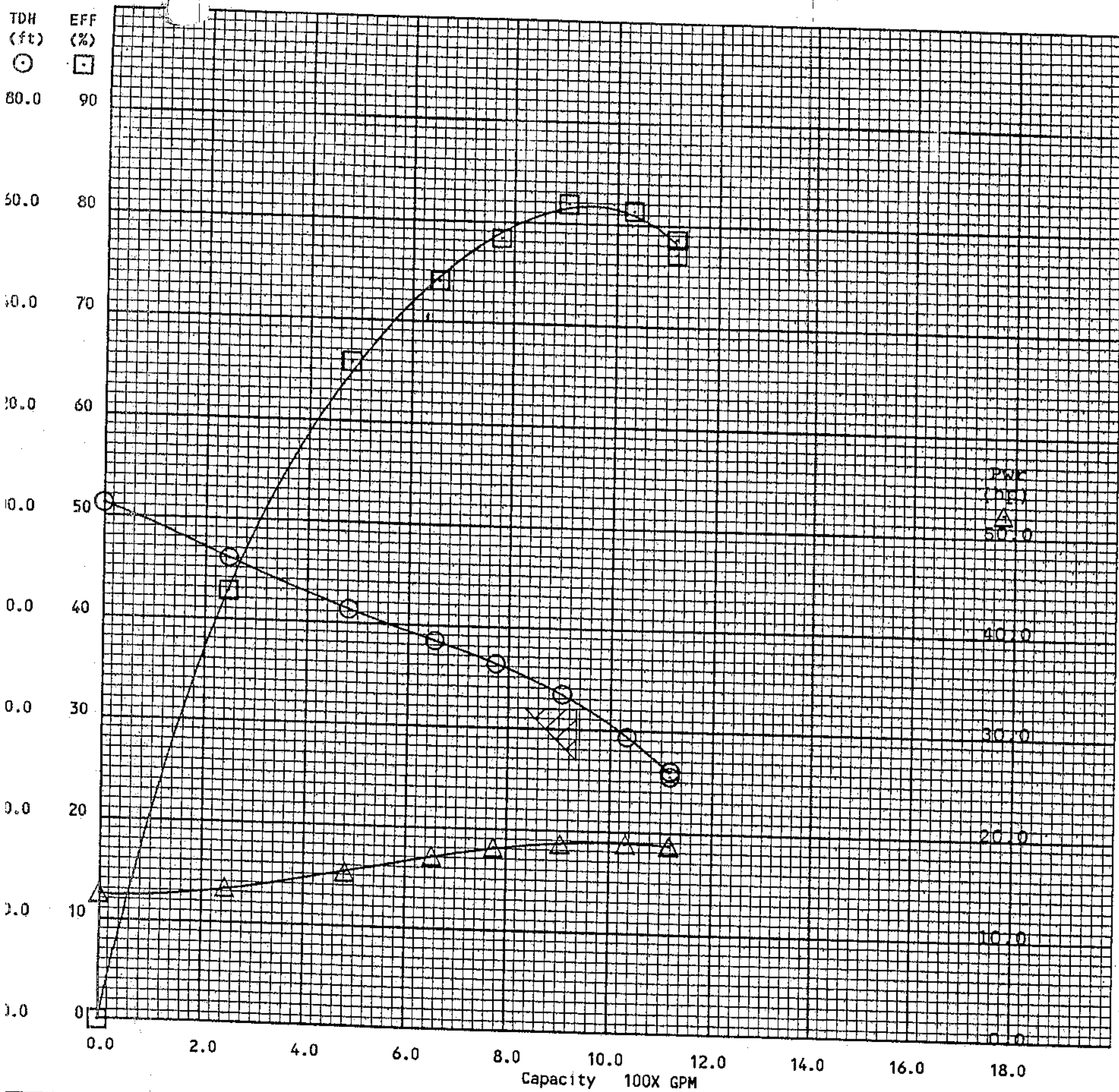
CASING DATA		
CI/EPOXY		
MATERIAL	FINISH	TONGUE

IMPELLER DATA		
BRONZE	1A	0.06
MATERIAL	FINISH	DISC. TIPS
		7.72
PATT.NO.	COMB.NO.	DIA

WORTHINGTON 10NKL-4	4	70-101067	93-70-101067-1	9-24-93	STA		30/1800	83	1160	E-232037
PUMP	STAGES	ORDER NO.	SERIAL NO.	DATE TESTED	TEST	APPROVED	TEST DRIVER	VENTURI	PLOTTED RPM	CURVE NO.

P-3/6 Bus to GSF

DRESSER PUMP DIVISION
DRESSER INDUSTRIES INC.
PUMP TEST DATA



RPM	GPM	TDH	BHP	EFF
1795.0	1401.1	159.8	69.1	81.8
1795.0	1597.3	140.3	69.6	81.3
1795.0	1725.5	124.7	69.2	78.5
1795.0	1727.6	121.9	69.1	77.0
1794.0	1727.6	124.2	69.0	78.5
1795.0	1199.2	173.5	67.1	78.3
1795.0	1009.7	183.8	63.4	73.9
1795.0	745.5	197.5	56.6	65.8
1795.0	379.9	220.1	49.5	42.7
1797.0	0.0	245.5	46.3	0.0

I CERTIFY THAT WITHIN THE ACCURACY OF TEST INSTRUMENTATION THIS TEST REPRESENTS THE PERFORMANCE OF 14KKL-2 PUMP # 93-101068-1

James Bin

SP.GR.:1.0

CASING DATA

MATERIAL	FINISH	TONGUE
CI/EPOXY		

IMPELLER DATA

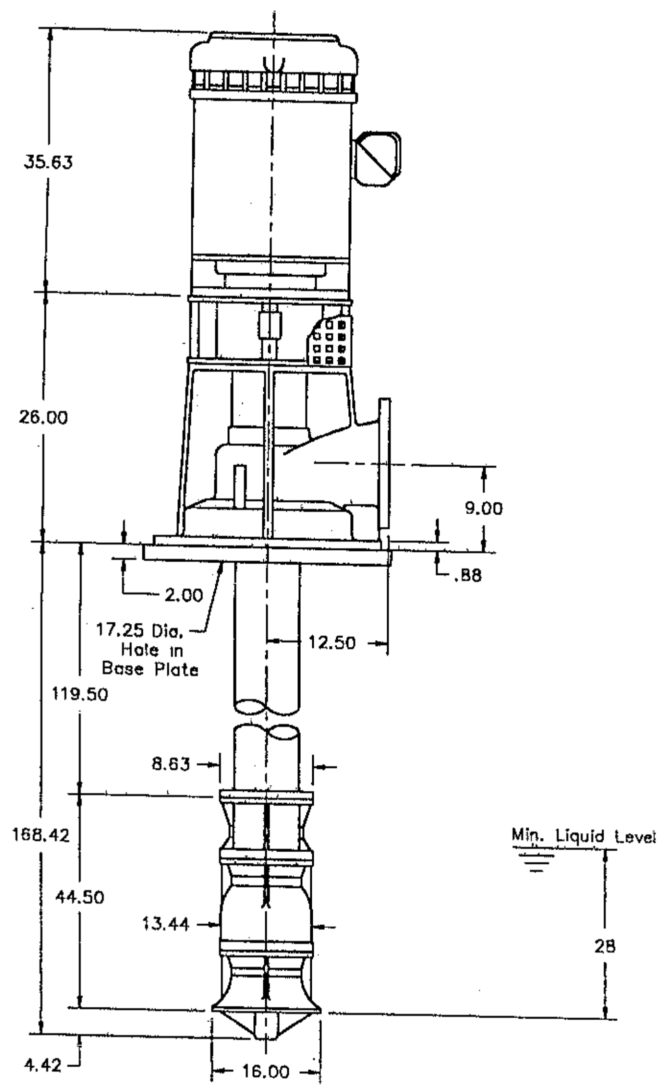
MATERIAL	FINISH	DISC. TIPS	DIA
BRONZE	1A	0.13	10.91

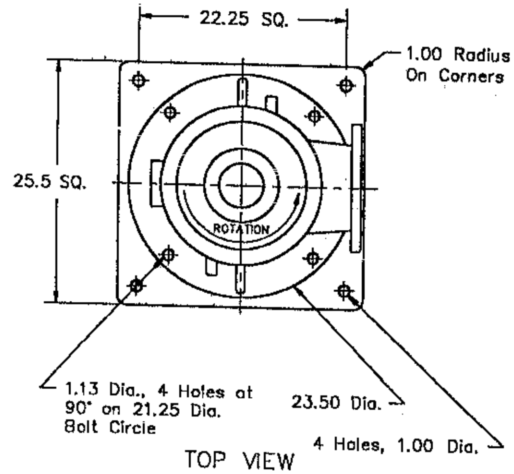
PUMP	STAGES	ORDER NO.	SERIAL NO.	DATE TESTED	TEST	APPROVED	TEST DRIVER	VENTURI	PLOTTED RPM	CURVE NO.
ORTHINGTON 14KKL-2	2	70-101068	93-70-101068-1	9-24-93	STA		200/1800	83	1160	E.232038

PATT.NO.	COMB.NO.

ALL DIMENSIONS
IN INCHES

CERTIFIED FOR CONSTRUCTION
BY [signature] DATE 7/14/93





TOP VIEW

MOTOR

25 H.P. Vertical HOLLOW Shaft
1200 R.P.M. 3 Phase 60 Cycle 460 Volts
TEFC Enclosure Mfg. U.S. Motors

DISCHARGE HEAD – TYPE W

8W Discharge Head
8" Discharge Flange matches 125# ANSI Dimensions flange holes straddle vertical centerline
Shaft Seal PACKING BOX

COLUMN

8 Column Pipe
1.25 Diameter Open Lineshaft

PUMP

2 Stage 14KKL Bowl ENCLOSED Impeller
935 USGPM 64 Ft. Total Head

MATERIALS

Bowls CAST IRON	Column STEEL
Impellers BRONZE	Brg. Retainer BRONZE
Pump Shaft 416 S.S.	Lineshaft C-1045
Bowl Brgs. BRONZE	Lineshaft Brgs. RUBBER
Head CAST IRON	Lineshaft Slv. 304 S.S.

Wear Rings (Bowl/Imp.) BRONZE/NONE
Driver Weight 690 lbs. Pump Weight 1580 lbs.
Pump will be shipped Assembled

Ingersoll-Dresser Pumps

GENERAL ARRANGEMENT DRAWING

NORTHEAST PUMP CO. INC.
28 CHARRON AVE.
NASHUA, NH 03063
TAG NO. P-3/6
IDP NO. 031-30650

DWG. NO. 70-101068	SCALE NONE	REV. 00
DRAWN GREG YOHE		DATE 07/15/93

BARTLETTA ENGINEERING
TAG.NO.: P-3/6

HYDRO GROUP, INC.
ENVIRONMENTAL PRODUCTS DIVISION

PACKED COLUMN AIR STRIPPER
PRODUCTION SPECIFICATIONS

I. Customer's Name:....................New England Division Corps of Engineers
Installation:.......................Cold Regions, Hanover New Hampshire
Customer Order No.:..................Cont. No. DACA33-92-C-0051

II. Hydro Group Production Number:......2896-86

III. Column: 2 Required

1. Drawing Number:.................16D2790
2. Capacity:......................850 gpm
3. Size:..........................84" dia. x 29'6" OAH
4. Inlet Pipe:....................8"
5. Outlet Pipe Size...............10"
6. Material:......................FRP
7. Remarks:.......................Tower to be freestanding

IV. Packing:

1. Type:..........................Jaeger Tripacks
2. Nominal Size:..................2"
3. Packing Depth:.................20'
4. Packing Material:..............Polypropylene
5. Packing Support Type:..........FRP Grating

V. Liquid Distribution:

1. Distributor Type:..............PVC Spray Nozzle
2. Redistributors:................(3) Provided

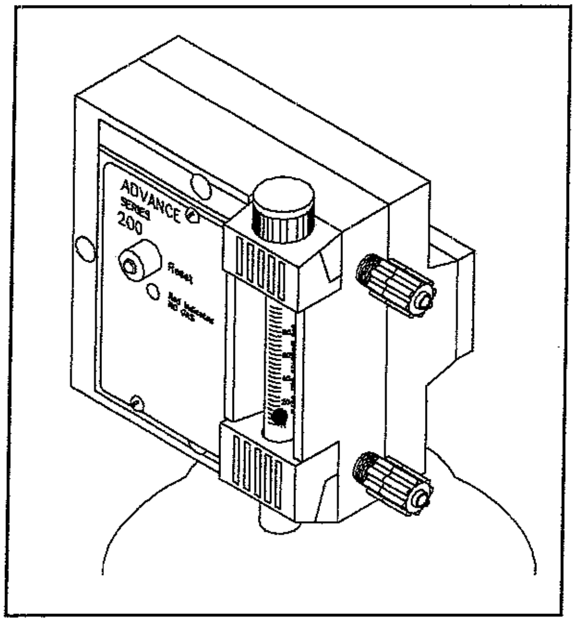
VI. Mist Eliminator:

1. Type:..........................Knitted Mesh
2. Thickness:.....................4"
3. Material:......................Polypropylene

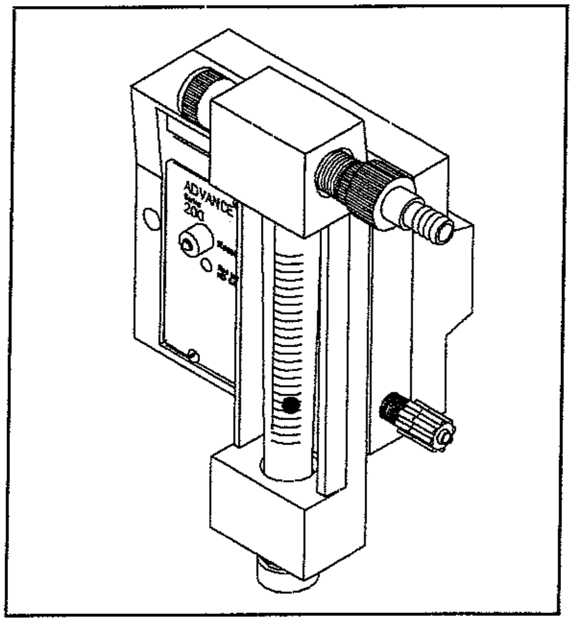
Instruction Manual — Series 200 ADVANCE® Cylinder or Ton Container Mounted Vacuum Regulators

SEVERN TRENT SERVICES

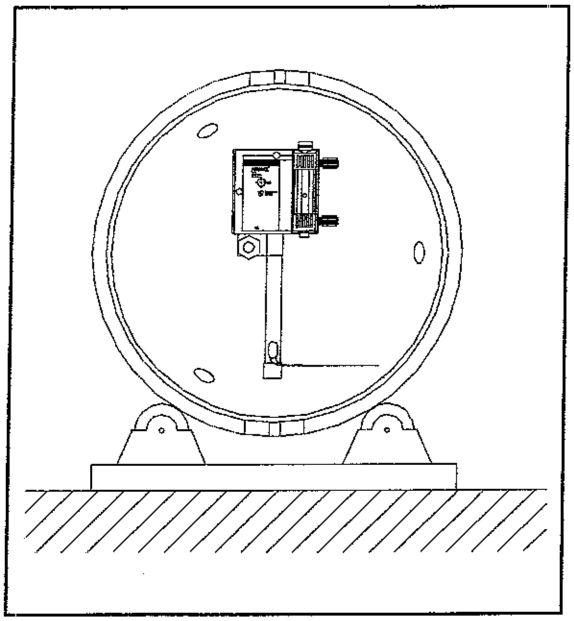
CAPITAL CONTROLS



100 & 250 PPD (2 & 5 kg/h) Cylinder Mounted



500 PPD (10 kg/h) Cylinder Mounted



500 PPD (10 kg/h) Ton Container Mounted

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call Severn Trent Water Purification for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. Severn Trent Water Purification, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact Severn Trent Water Purification, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into Severn Trent Water Purification equipment is conditioned on the customer absolving Severn Trent Water Purification from any consequences of such a decision.

Severn Trent Water Purification has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. Severn Trent Water Purification, Inc. cannot be responsible deviations from the recommended instructions that may result in a hazardous or unsafe condition.

Severn Trent Water Purification, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that Severn Trent Water Purification, Inc.

Severn Trent Water Purification, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped "F.O.B. Colmar" or to Severn Trent Water Purification for equipment shipped "F.O.B. Jobsite". Do not install damaged equipment.

SEVERN TRENT SERVICES, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
IS ISO 9001: 2000 CERTIFIED

Table of Contents

1 INTRODUCTION

1.1 General

The ADVANCE® vacuum regulators are expertly engineering and carefully tested to assure years of satisfactory operation. They are constructed of the finest materials available for gas service. Correct installation and proper care will ensure best operation. Read instructions carefully and save for future reference.

This instruction manual covers the Series 200 vacuum regulator. Refer to the following instruction manuals for other components:

Remote Meter Panels 100 6015

Diaphragm Ejectors 122.6006

Diaframless Ejectors 122.6010

Switchover Module 100.6030 (B3.8022)

Also, the following literature is referenced throughout:

Changing Gas Cylinders Instruction Card R-1974

Vacuum Line Size Requirements 121.3003 (A2.62250)

Manifolds 120.6001 (B3.8021)

Universal Yoke Conversion for Ton Container Yoke Assembly 100.6012 (B3 8034)

1.2 Warranty

See Bulletin 005.9001 (B3.8000) for ADVANCE® equipment warranty.

NOTE: The Series 200 vacuum regulator is designed for use in systems where the feed rate is manually set and operation is continuous or stop/start. The ADVANCE® equipment warranty and service policy is null and void, as it pertains to user protection, if the Series 200 vacuum regulator is misapplied.

1.3 Standard Equipment

The Series 200 gas feeder system consists of the following major components and accessories:

1.3.1 Vacuum regulator, which connects to the gas container valve or similar valve on a gas manifold.

1.3.2 Ejector-check valve assembly with nozzle and diffuser. See Instruction Manuals 122.6006 or 122.6010.

1.3.3 If remote metering or multiple feed points are provided, separate meter panels are included. See Instruction Manual 100.6015.

1.3.4 If constant gas supply is required, a switchover system will be provided. Refer to Instruction Manual 100.6030 (B3.8022).

1.3.5 Accessories

a. A length of hose for connecting the ejector water supply to the ejector nozzle.

b. An ejector water supply hose adapter.

c. Hose clamps.

d. A length of tubing for vacuum regulator vent and vacuum regulator vacuum lines.

e. Lead gaskets for connecting vacuum regulator yoke to gas container valve

f. Spare parts.

1.3.6 Additional parts needed for installation:

a. Water supply shutoff valve.

b. Y-Strainer for water line.

c. Water pressure gauge(s).

NOTE: This instruction manual covers the vacuum regulator only. Because the vacuum regulator requires an ejector to operate, ejectors will be referenced throughout. Installation of a complete system is covered within.

1.4 Specifications

1.4.1 Gas Flowmeter Data - Chlorine

Note: The capacities listed are for chlorine only. To determine feed rates for other gases; multiply each chlorine value by: 0.95 for sulfur dioxide, 0.50 for ammonia, 0.78 for carbon dioxide

Capacities		
Model 201	**Model 202**	**Model 203**
3" (76 mm) Flowmeter Tube Length	**3" (76 mm) Flowmeter Tube Length**	**6" (152 mm) Flowmeter Tube Length**
0.6 PPD (11 g/h) 1.5 PPD (28 g/h) 4 PPD (75 g/h) 10 PPD (200 g/h) 25 PPD (0.5 kg/h) 50 PPD (1 kg/h) 100 PPD (2 kg/h)	25 PPD (0.5 kg/h) 50 PPD (1 kg/h) 100 PPD (2 kg/h) 200 PPD (4 kg/h) 250 PPD (5 kg/h)	50 PPD (1 kg/h) 100 PPD (2 kg/h) 200 PPD (4 kg/h) 300PPD (6 kg/h) 500 PPD (10 kg/h)

Accuracy - ±4% of maximum flowmeter capacity (0.6 PPD/11 g/h within ±8% of full scale)

Tubing Connections:

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

2 OPERATION

2.1 General

The vacuum regulator design provides for conveying the gas under vacuum from the vacuum regulator to the ejector-check valve assembly to ensure complete system safety. The vacuum regulator design permits the entire system to be vacuum checked in the field without using special tools or manometers. The vacuum regulator is constructed of materials specially selected for wet or dry gas services. All springs used in the vacuum regulator are of a tantalum alloy for chlorine and sulfur dioxide, and stainless steel for ammonia. The rate valve and seat are constructed of fine silver for chlorine and sulfur dioxide, and stainless steel for ammonia. A double thickness main diaphragm is provided for vacuum regulation.

2.2 Installation

2.2.1 Gas Cylinder

When handling potentially dangerous gas, the following rules must always be followed:

a. Never move a cylinder unless the valve protection cap is screwed on tightly.

b. Locate the cylinders where they will not be bumped or damaged.

c. A safety chain should be placed around the cylinders and secured to a wall or support.

d. To achieve the desired feed rate, the temperature should be 68°F (20°C) or higher. Air circulation should be provided around the cylinders with a fan. Never apply direct heat to a cylinder. As the ambient temperature decreases, maximum feed rates will be reduced.

2.2.2 Ton Container

When handling potentially dangerous gas, the following rules must always be followed:

a. Never move the ton container unless the valve protection hood is in place.

b. Locate the container(s) where they will not be bumped or damaged.

c. A pair of trunnions should be placed under the container for support and ease of positioning of the outlet valves.

d. Mounting the vacuum regulator directly on the ton container, in most cases, eliminates the need for a heated room.

2.2.3 Mounting the Vacuum Regulator on a Cylinder - (Refer to Instruction Card R-1974 and Figure 1)

a. Unscrew the valve protection cap from the gas cylinder. Ensure the gas cylinder valve is closed.

b. Unscrew the cap nut that covers the gas cylinder valve outlet. Check for leaks around the cylinder valve.

c. Remove all shipping tape from the vacuum regulator. (DO NOT remove the filter floss or inlet filter screen inserted in the vacuum regulator inlet.)

d. Remove any dirt in the cylinder valve outlet or on the cylinder outlet gasket surface.

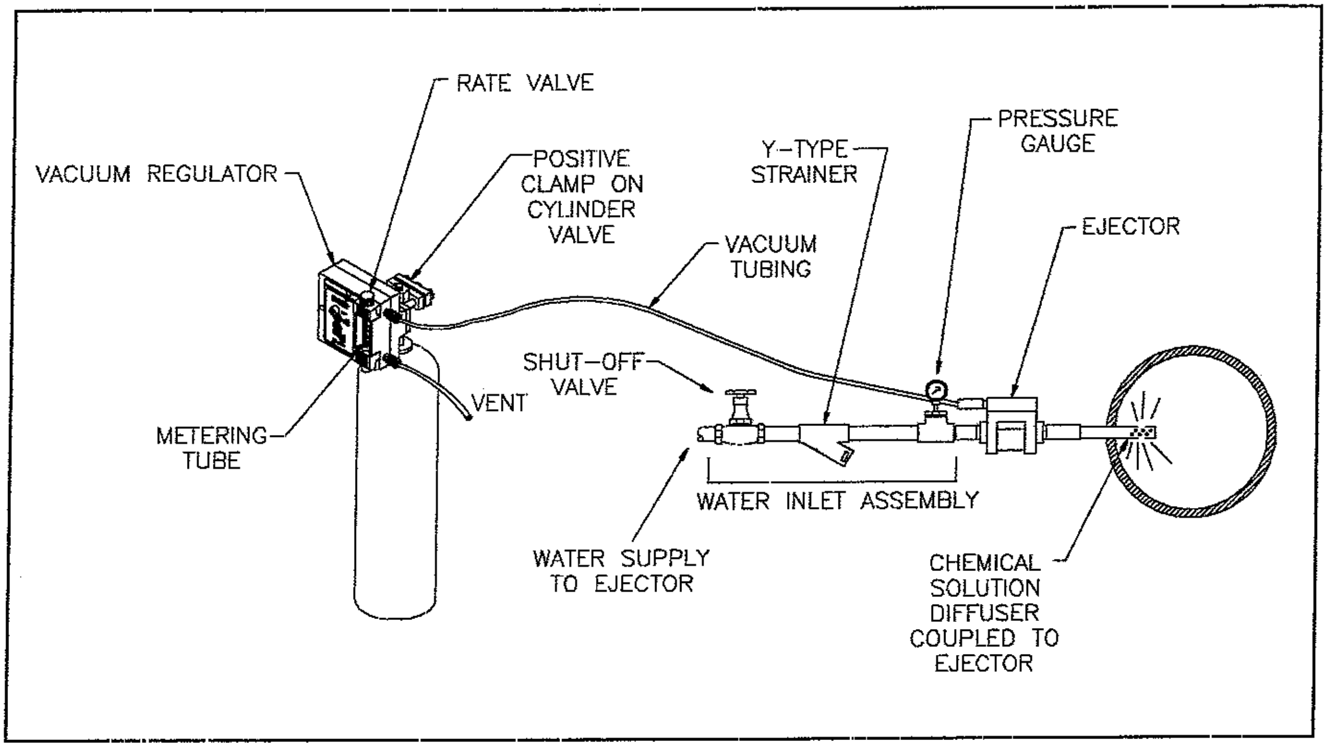


Figure 1 - Typical Cylinder Mounted Installation

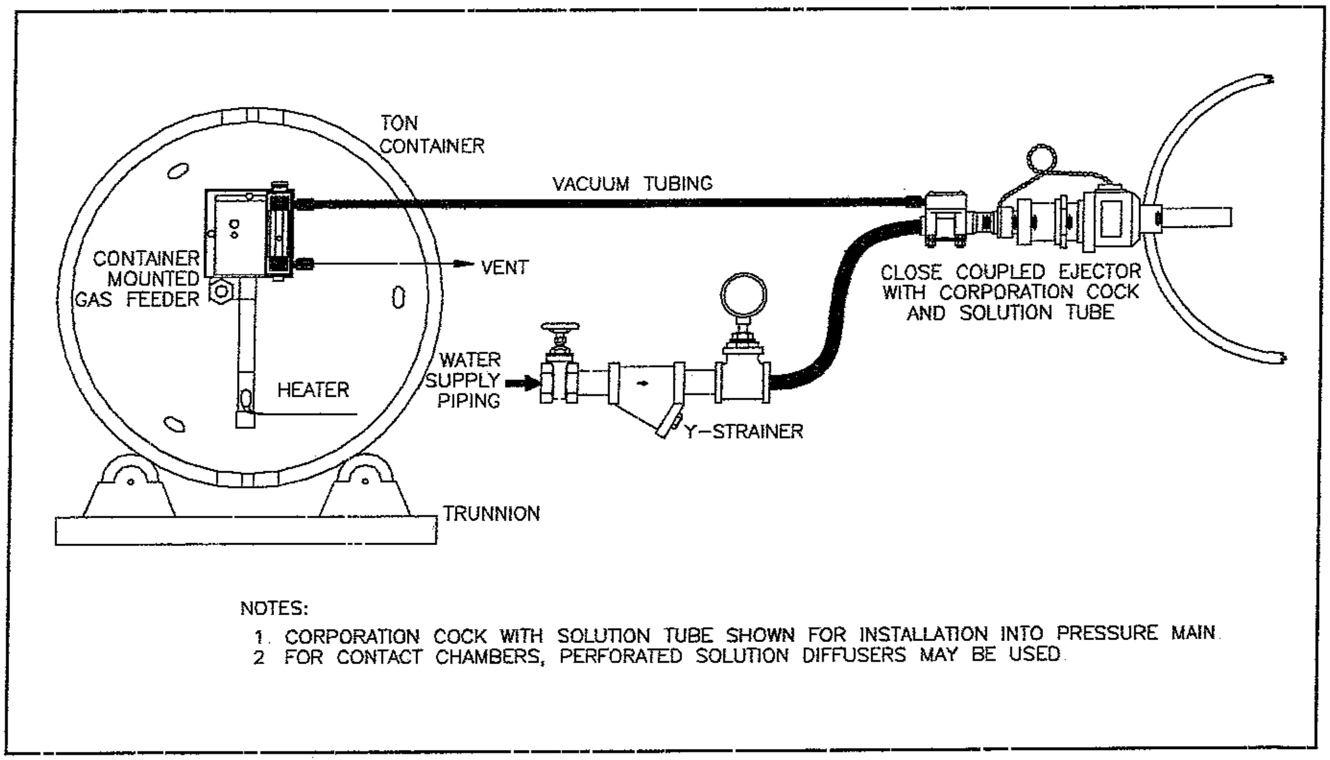


Figure 2 - Typical Ton Container Mounted Installation

e. Unscrew the vacuum regulator yoke screw until the slide bar can be pushed all the way back.

f. Place a 1/16" thick lead gasket over the gas inlet of the vacuum regulator. **Never re-use the lead gasket. Replace the lead gasket each time the gas cylinder is changed.** See Operation section H for discussion when using special purpose offset yoke.

g. Place the vacuum regulator yoke over the cylinder, engage the vacuum regulator inlet properly with the valve outlet, and tighten the yoke screw. **Excessive tightening should be avoided.**

h. Refer to Figure 4 for wiring a loss of gas switch, if supplied.

2.2.4 Mounting the Vacuum Regulator on a Ton Container - (Refer to Instruction Card R-1974 and Figures 2, 5, 6 and 7)

On ton containers, there are two valves; a gas outlet valve and a liquid outlet valve. The valve's function is dependent upon the position of the ton container. After rotating the ton container, aligning one valve directly over the other valve, the top valve will be the gas outlet and the bottom valve the liquid outlet valve. If the container is then rotated 180°, the valve now on top will be the gas outlet valve. (Refer to Figure 6)

Figure 6 shows the top gas valve facing right. Effective January 1993, the Chlorine Institute standardized on this valve direction and eliminated left facing valves. However, it is not known when and if all chlorine suppliers have made this change. Capital Controls still offers a right hand ton container mounting yoke, and a universal yoke that can be mounted on either the left or right facing valves. (Refer to Figure 7)

To mount the vacuum regulator on the ton container valve, proceed as follows:

a. With the ton container in place, remove the protection hood.

b. Rotate the ton container until the valves are in their vertical position (gas outlet valve over the liquid outlet valve).

c. Facing the end of the ton container, observe the direction of the top valve outlet. Should it face to the right, a right inlet will be required on the vacuum regulator, Verify the correct inlet on your vacuum regulator.

d. Before removing the cap nut, which covers the ton container valve outlet, check to be sure the gas valve is closed. Remove the cap nut.

e. Remove all shipping tape from the vacuum regulator. (Do NOT remove the filter floss or inlet filter screen inserted into the vacuum regulator inlet).

f. Remove any dirt that may be in the container valve or on the outlet gasket surface.

g. Unscrew the vacuum regulator yoke screw until the slide bar can be pushed all the way to the back.

h. Place a 1/16" thick lead gasket over the gas inlet of the vacuum regulator. **NEVER re-use lead gasket.** Replace the lead gasket each time the gas cylinder is changed.

I. Mount the vacuum regulator on the container valve by placing the yoke over the valve, engage the gas inlet with the valve outlet, and tighten the yoke screw. **Excessive tightening should be avoided.**

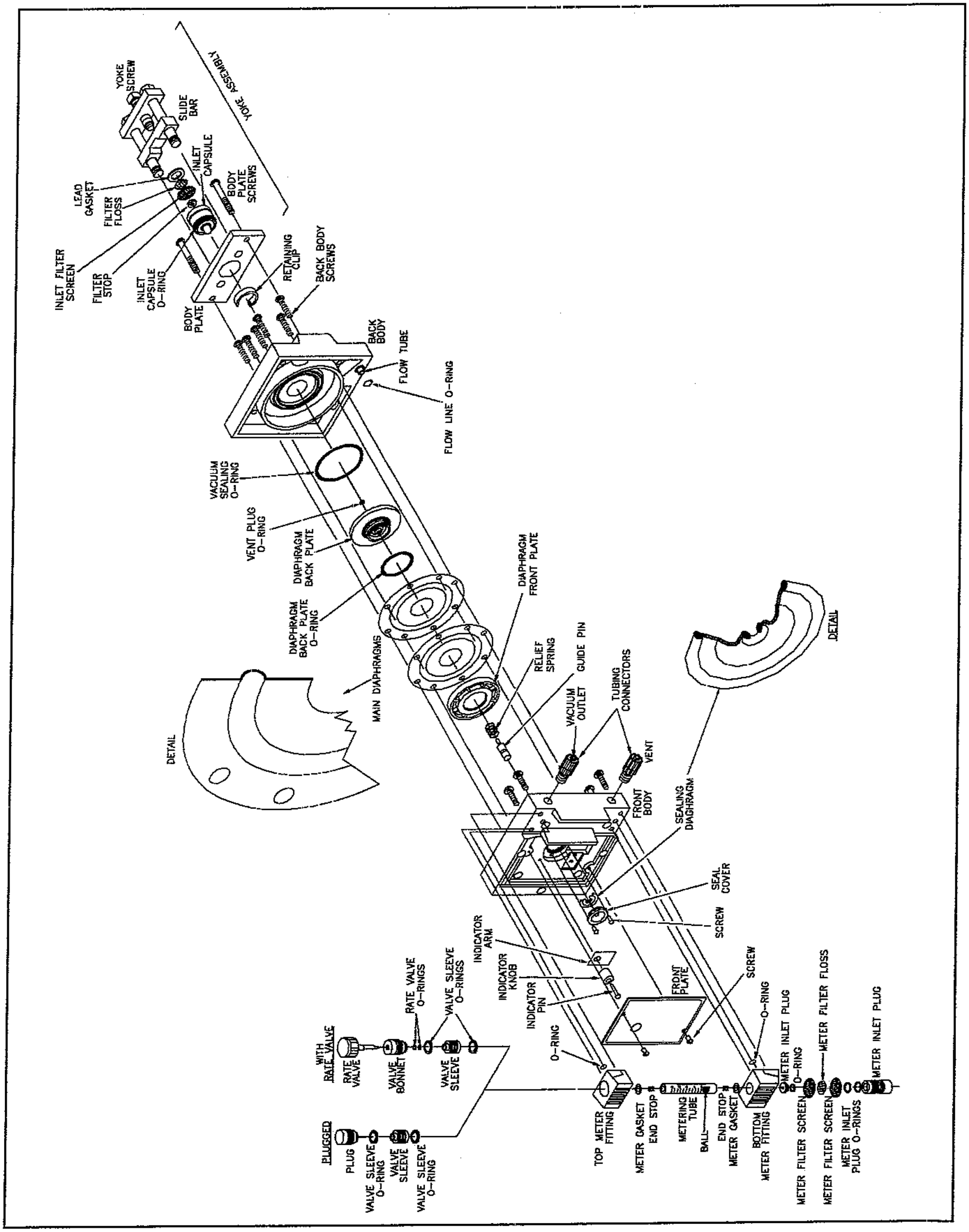


Figure 3 - Vacuum Regulator Exploded View

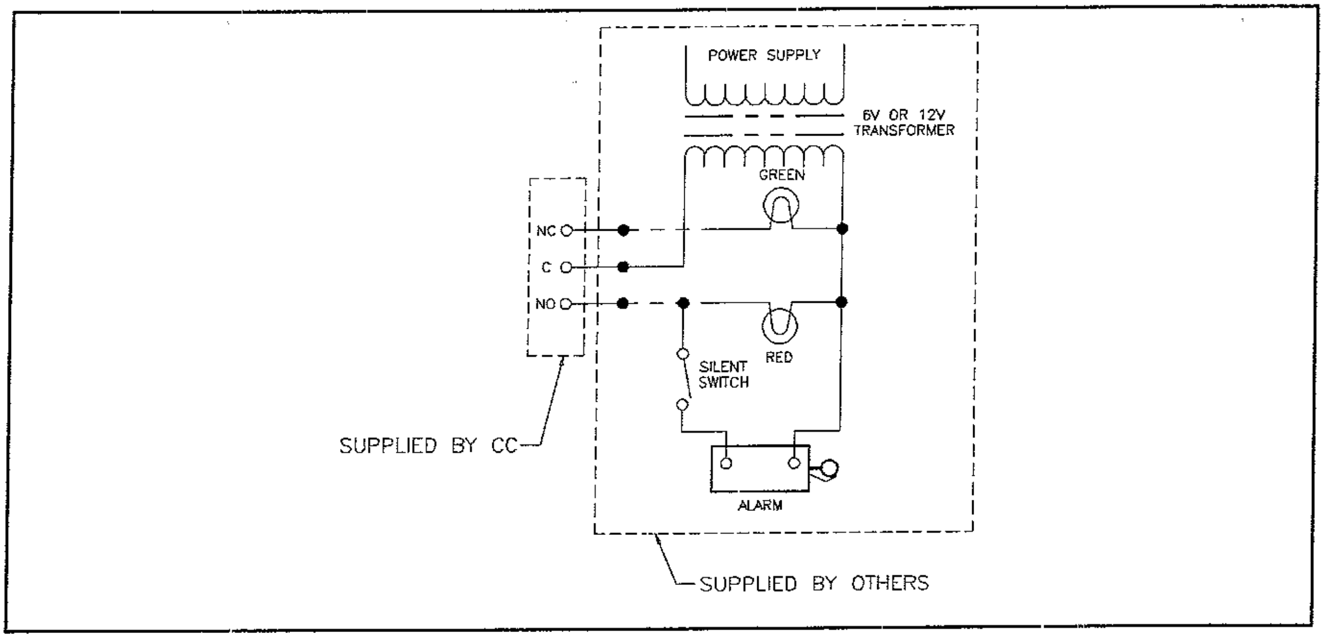


Figure 4 - Loss of Gas Switch Wiring Diagram

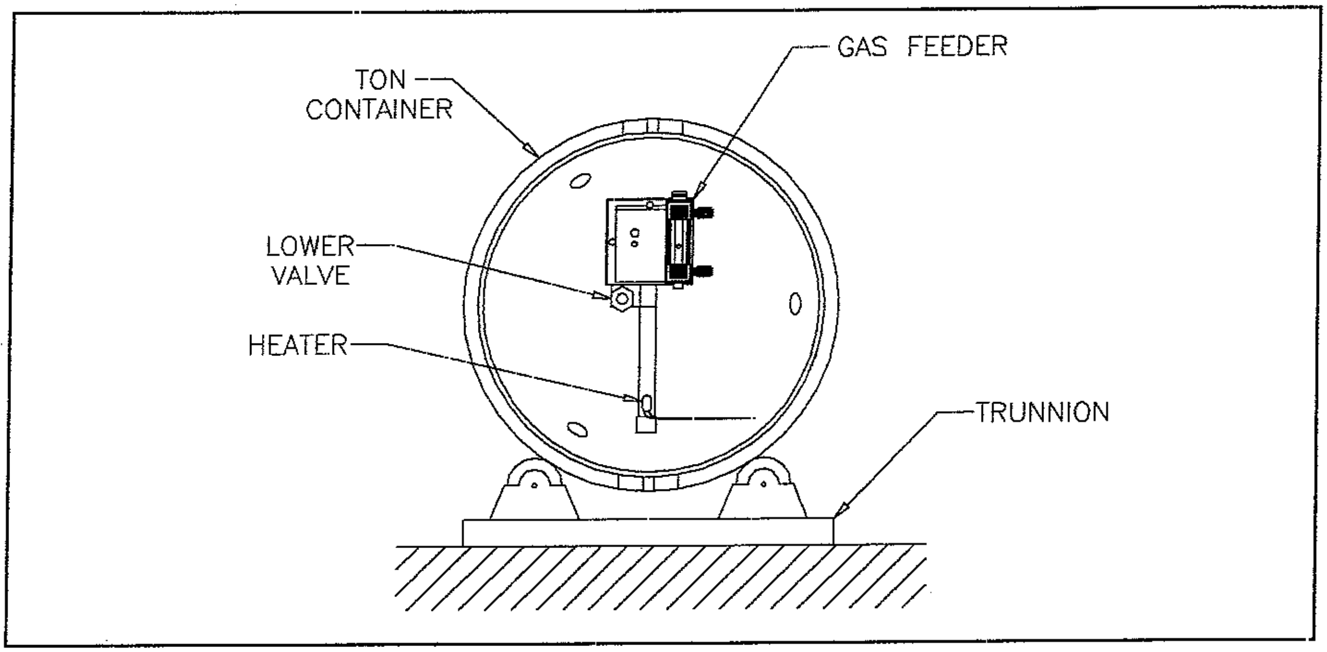


Figure 5 - Ton Container Valve Positioning

j. Power the 25 watt heater to warm the liquid trap.

k. If loss of gas switch is supplied, refer to Figure 4 for wiring.

2.2.5 Mounting on a Manifold Assembly

The manifold assembly (supplied or existing) provides a gas valve identical to the cylinder valve (less fusible plug) for mounting on the vacuum regulator. During periods of manifold maintenance, the vacuum regulator may be direct cylinder mounted or ton container mounted. Direct mounting eliminates the potential of gas leaks and is always the preferred mounting. Also refer to the manifold assembly Instruction Manual 120.6001 (B3.8021). For mounting vacuum regulators on a manifold valve, follow instructions given previously in Operation, Section 2.2.3, items b-g.

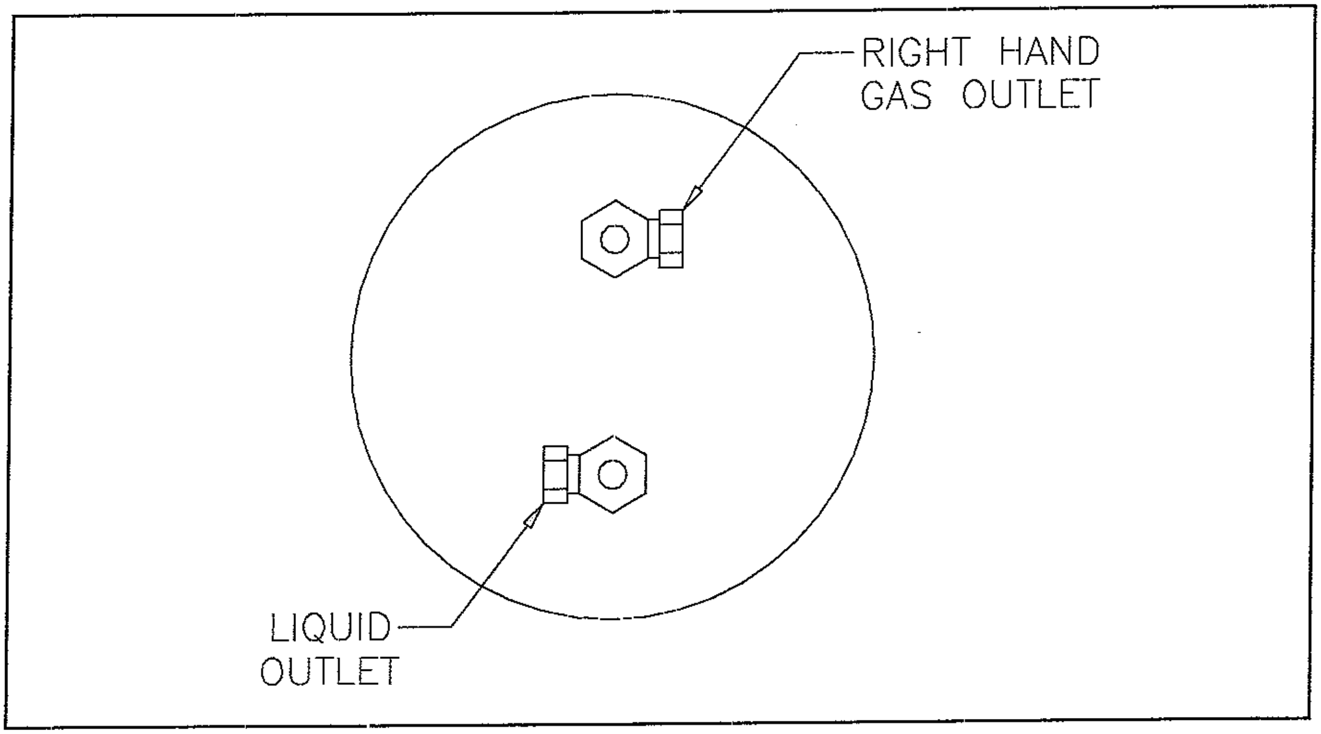


Figure 6 - Ton Container Gas and Liquid Valve Positions

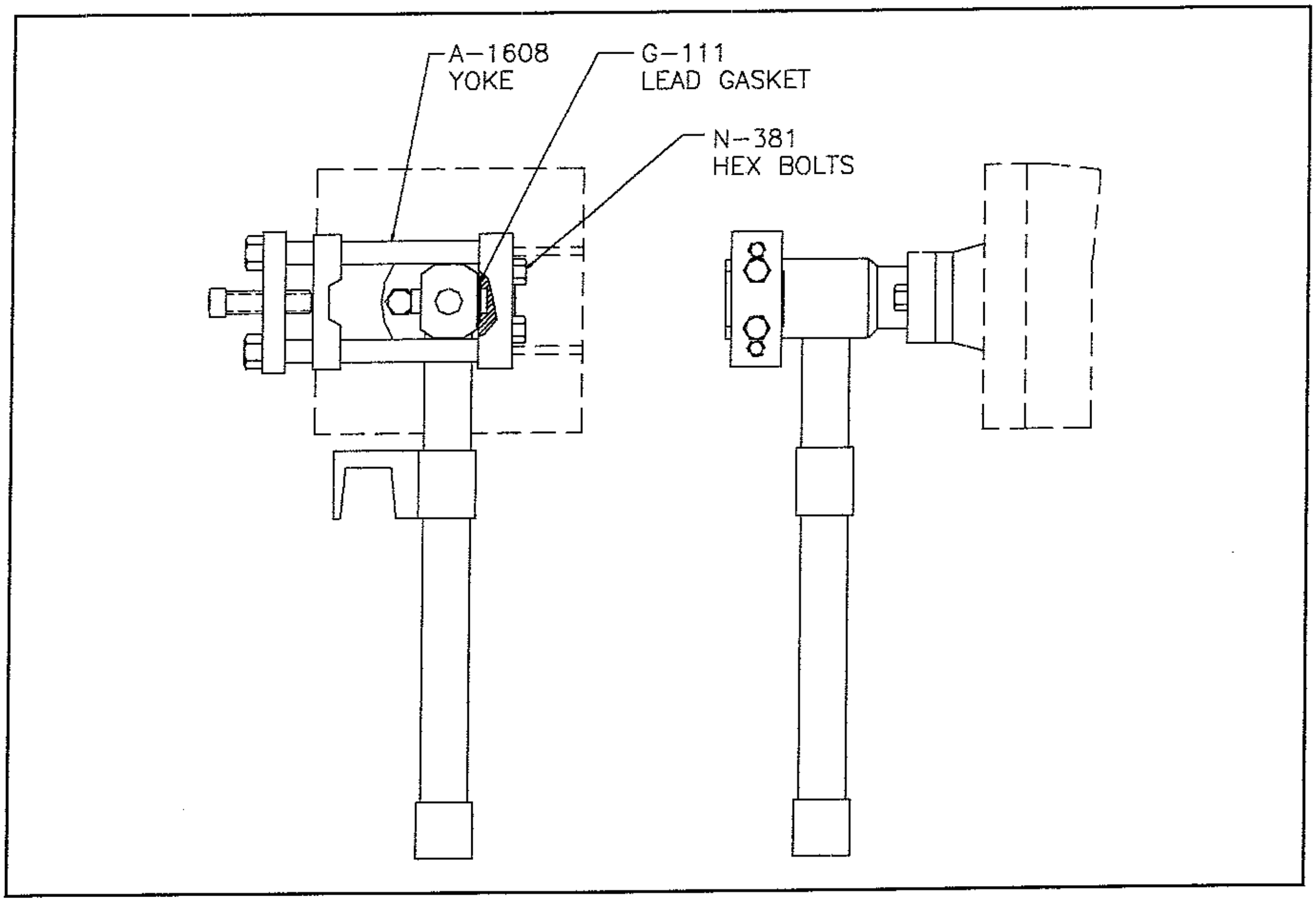


Figure 7 - Universal Yoke Assembly

2.2.6 Connecting the Vacuum Regulator to the Ejector and Vent - (Refer to Figures 1 and 2)

Black polyethylene tubing is normally used for the vacuum line between the vacuum regulator and ejector, and for the emergency vent. Use enough length for each line to allow vacuum regulator movement from one gas source to another.

Remove the connector nut from the connector and slip it onto the tubing. Push the tubing onto the connector and tighten the connector nut HAND TIGHT.

The upper connection on the vacuum regulator is for vacuum tubing to ejector. The lower connection is for a vent line to a safe location outside the building.

General Design Note: Routing vacuum tubing through unventilated conduit is discouraged. A minute portion of gas flowing through tubing under vacuum conditions, will slowly diffuse at a molecular level through its walls and collect in the closed conduit over an extended period of time.

2.2.7 Vent Line(s)

Whatever the vacuum regulator size, location, or mounting, it is equipped with a vent connection. DO NOT MANIFOLD VENT LINES from several vent equipped devices; run separate and independent vents to a safe area where a discharge of gas being dispensed can be tolerated. The vent line must slope downward from the vacuum regulator to provide a positive drain, preventing accumulation of any moisture in the vent line. The vent line must be vented to an atmospheric source in order for the vacuum regulator to operate. Install an insect screen over the end of the tubing to prevent blockage.

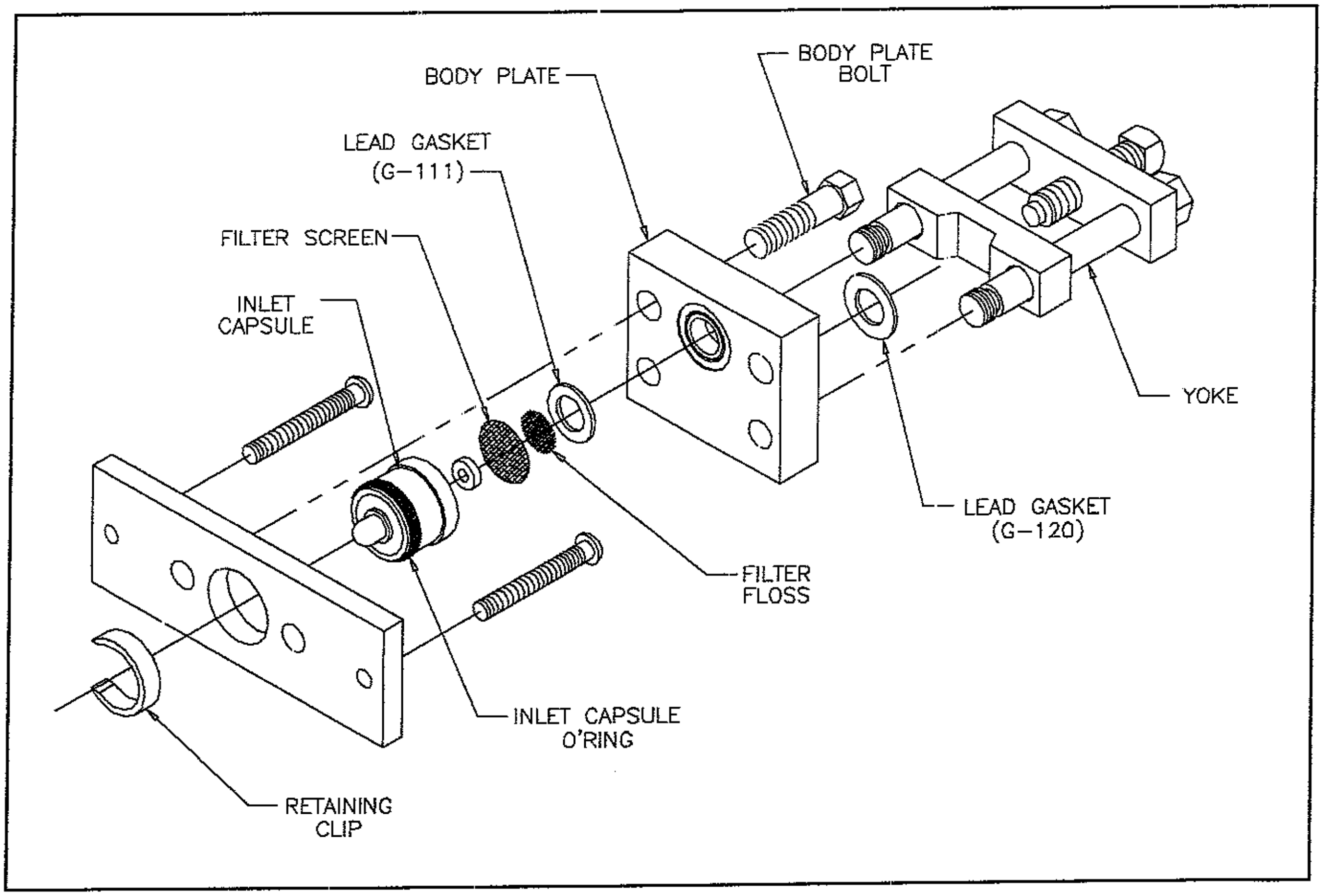


Figure 8 - Offset Yoke Assembly

2.2.8 Special Offset Yokes - U.S. Valve and Cylinder Mounting Only (Refer to Figure 8)

Gas chlorinators, Models 203C1, 203C3 and 203C5; and all gas sulfonators (500 PPD [10

kg/h]) are furnished with a special offset yoke that permits the unit to be mounted directly on a 150 pound U.S. gas cylinder. The offset yoke lifts the regulator body up and away from the cylinder valve eliminating mechanical interference with a cylinder.

Because of the special nature of the offset yoke, it is necessary to use the following two (2) lead gaskets:

a. Part number G-111. Change when servicing the inlet filter. Twelve (12) are supplied with each shipment. Provides seal between offset yoke and inlet.

b. Part number G-120. Change with every new 150 pound gas cylinder. Twelve (12) supplied with shipment. Provides seal between offset yoke and cylinder valve.

NOTE: INCORRECT GASKETS MAY NOT SEAL PROPERLY.

3 START-UP

3.1 Ejector

The ejector, its water supply and solution lines, must be properly installed and operating before checking the vacuum regulator. Unless the ejector is creating a vacuum, the vacuum regulator will not work. (Refer to Figures 1 and 2, and Instruction Manuals 122.6006 or 122.6010))

3.1.1 Disconnect the vacuum tubing from the ejector.

3.1.2 Open the ejector water supply valve. The ejector should now be in operation and creating a vacuum.

3.1.3 Put your finger on the vacuum connector opening and feel the vacuum. There should be no doubt that a vacuum exists. If there is no vacuum, refer to the Operation Section 2.2.6 and be certain the supply pressure is sufficient and the nozzle or piping is not plugged. Correct the condition and obtain proper vacuum before proceeding.

3.1.4 Re-connect the vacuum tubing to check the vacuum regulator. Leave the ejector running.

3.2 Check Vacuum Regulator For Leaks

Have a squeeze bottle 1/4 full of household ammonia or stronger ammonia solution to check for chlorine or sulfur dioxide leaks. Use chlorine bleach to check for ammonia leaks.

3.2.1 With the ejector operating, and the gas container valve closed, the ball in the metering tube will drop to the bottom and remain there. If the ball does not drop or bounces, there is a leak around the lead gasket, where the vacuum regulator connects to the cylinder or a loose connection in the vacuum regulator upstream of the metering tube. If the unit is ton container mounted, the leak could also be in another joint of the yoke assembly. Check and correct.

3.3.2 The supply indicator on the face of the vacuum regulator will show RED. turning the indicator knob to RESET will not stop the movement of the indicator and it will return to RED.

3.3.3 Close the ejector water supply valve to stop operation of the ejector.

3.2.4 Disconnect the vacuum tubing at the vacuum regulator to allow air to enter the system

3.2.5 Reconnect the vacuum tubing.

3.2.6 Open the gas container valve 1/4 turn and close immediately.

3.2.7 To test the yoke assembly and lead gasketed valve connection for leaks, hold the squeeze bottle with test solution below the lead gasket, and squeeze (fumes only). If gas is leaking, a white smoke will appear. Tighten or replace the lead gasket and eliminate the leak.

For ton container mounted units, repeat the leak test at other joints of the yoke assembly and tighten bolts as necessary, not exceeding 8 foot pounds torque on the hex head bolts.

3.2.8 Open the gas container valve 1/4 turn, and leave open. Recheck for leaks.

3.2.9 Turn on the water supply valve to the ejector and adjust the rate valve to the desired gas flow rate. Flow rates in PPD (pounds per 24/hours), g/h (grams per hour) or kg/h (kilograms per hour) are read on the metering tube scale at the center of the ball.

NOTE: NEVER use the vacuum regulator rate valve (if supplied) to shut off the gas supply. This valve is for adjusting flow rate while the system is in operation. If used for shutoff, this valve will be damaged. To shut off the gas, close the container valve.

3.3 Ton Container Considerations

3.3.1 Liquid Trap Heater (Never supplied for ammonia)

The function of the liquid trap is to collect the initial surge of liquid chemical from the gas valve when it is first opened. (See Section 3.3.2).

The function of the trap heater is to provide heat to vaporize the collected liquid.

The trap may collect liquid after the initial surge is vaporized, therefore, it is essential that the heater remain powered continuously.

3.3.2 Excessive Liquid Chemical in the Drip Leg

The volume of the drip leg on a vacuum regulator is 5 ½ cubic inches. This is more than adequate to accept the volume of liquid which may be educted from the gas discharge valve from the ton container when it is first opened. The volume of a 1/2" diameter eduction pipe in a U.S. standard ton container is approximately 3.7 cubic inches.

If the upper eduction pipe in a full ton container is faulty, or if it becomes necessary to remove the vacuum regulator from the ton container shortly after the ton container has been first opened, the drip leg of the ton container mounted vacuum regulator may be flooded with liquid chemical.

If this occurs, proceed as follows:

a. Isolate the faulty eduction pipe from the drip leg by closing the upper valve.

b. Be sure the drip leg heater and ejector are operating and the rate valve is open.

   NOTE: The drip leg will function as a low-power vaporizer, and is capable of producing chlorine gas at an average rate of about 10 PPD (200 g/h) and sulfur dioxide gas at an average rate of about 8 PPD (160 g/h).

c. Allow about 90 minutes for complete vaporization. During this period, the vacuum regulator will feed intermittently because gas is drawn through the rate valve faster than it becomes available by vaporization. This cycle will cease when the drip leg is empty.

d. When the drip leg is empty, remove the vacuum regulator and rotate the ton container 180°. The valve to which the vacuum regulator was connected is now on the bottom of the container.

e. Re-connect the vacuum regulator and drip leg assembly to the upper valve on the ton container.

4 SHUTDOWN

4.1 Periodic Shutdown

4.1.1 Continue ejector operation.

4.1.2 Close the gas valve on the container **NOT THE RATE VALVE ON THE VACUUM REGULATOR.**

4.1.3 Observe the loss of gas supply indicator on the front of the vacuum regulator. When it show **RED**, the gas flow will begin to decrease. The metering ball should drop to the bottom of the metering tube and remain there. If it does not drop, or bounces, the gas container valve may not be completely closed, or the vacuum regulator may have a vacuum leak upstream of the metering tube. Attempt to reset the loss of gas supply indicator. It should turn freely and always reset in the **RED** position, indicating gas flow has stopped.

4.1.4 Close the ejector water supply valve.

4.2 Long Term Shutdown

4.2.1 Continue ejector operation.

4.2.2 Close the gas valve on the container **NOT THE RATE VALVE ON THE VACUUM REGULATOR. OR REMOTE METER PANEL IF PROVIDED)**

4.2.3 Observe the supply indicator on the front of the vacuum regulator. When it shows RED, the gas flow will begin to decrease. The metering ball should drop to the bottom of the metering tube and remain there. If it does not drop, or bounces, the gas container valve may not be completely closed. Attempt to reset the supply indicator. It should turn freely and always return to the RED position, indicating gas flow has stopped.

4.2.4 When all of these steps have been completed, it is safe to remove the vacuum regulator from the gas container valve. Continue ejector operation.

4.2.5 Momentarily disconnect, then re-connect the tubing at the vacuum regulator outlet. The vacuum sealing o-ring will open, drawing air through the gas inlet.

4.2.6 Allow the vacuum regulator to operate on air for a few minutes to purge the remaining gas from the system.

4.2.7 Turn off the ejector water supply and drain the ejector. Disconnect the tubing and hoses. Disconnect the vacuum regulator and ejector. Store the vacuum regulator and ejector in a clean and dry environment.

4.3 Changing Cylinders (Refer to Instruction Card R-1974)

After shutdown of system, as previously detailed, follow this procedure to change a cylinder:

4.3.1 Loosen the vacuum regulator yoke screw. Remove the vacuum regulator from the gas container valve.

4.3.2 Replace cylinder.

4.3.3 Remove the old lead gasket and discard. Remove filter floss and replace, being careful not to lose the screen under the filter. (Do not over stuff inlet. Replace only amount removed). Inspect and clean the mating surfaces of the vacuum regulator and the gas valves.

4.3.4 Place a new 1/16" thick lead gasket over the gas inlet of the vacuum regulator. Never use other types of gaskets or gasket materials. Never re-use the lead gasket.

4.3.5 Mount the vacuum regulator on the cylinder valve by placing the yoke over the valve, engage the vacuum regulator inlet properly with the valve outlet, and tighten the yoke screw. Do not tighten excessively. Make certain the ejector water supply is turned off.

4.3.6 Slightly open the cylinder gas valve and immediately close. Check for leaks with ammonia vapor. If leaks exist, turn on the ejector and repeat steps 4.2.1-4.2.3 of the Long-Term Shut Down, Section 4.2. Correct leaks.

4.4.7 Turn on the ejector water supply.

4.3.8 Open gas container valve slowly, approximately 1/4 turn and leave wrench on the valve. Reset the gas supply indicator on the vacuum regulator.

4.4 Changing Ton Containers

After shut-down of system, as previously detailed, follow this procedure to change ton container: (Refer to R-1974)

4.4.1 Loosen the vacuum regulator yoke screw. Remove the vacuum regulator from the gas valve.

4.4.2 Replace the ton container. Make sure the full container is oriented with the valves in the vertical position (one valve above the other).

4.4.3 Remove and discard the old lead gasket and discard. Remove filter floss and replace, being careful not to lose the screen under the filter. (Do not over stuff inlet. Replace only amount removed). Inspect and clean the mating surfaces of the vacuum regulator and the gas valves.

4.4.4 Place a new 1/16" thick lead gasket over the gas inlet of the vacuum regulator. Never use other types of gaskets or gasket materials. Never re-use the lead gasket.

4.4.5 Position the vacuum regulator on the upper valve on the new ton container and tighten the yoke screw. Do not tighten excessively. Make certain the ejector water supply is turned off.

4.4.6 Be sure the heater is powered and operating. An operating heater provides the heat of vaporization to any trapped liquid.

4.4.7 Slightly open the ton container gas valve and immediately close. Check for leaks with ammonia vapor. If leaks exist, turn on the ejector and repeat steps 4.2.1-4.2.3 of the Long-Term Shutdown, Section 4.2. Correct leaks.

4.4.8 Turn on the ejector water supply.

4.4.9 Open gas container valve slowly, approximately 1/4 turn and leave wrench on the valve. Reset the gas supply indicator on the vacuum regulator.

5 SERVICE

5.1 Vacuum Regulator

It is recommended that the Gas Dispensing System be inspected and serviced a minimum of once per year.

More frequent service periods may be required due to: 1) the type, quality and quantity of the gas being handled, 2) the complexity of the gas supply system and 3) operation procedures.

More frequent service periods are especially indicated when venting of the VR is occurring during the one year operational period. This is usually indicative of foreign debris holding the inlet valve open or destruction of the inlet valve parts caused by the gas quality not up to industry purity standards.

Preventative maintenance kits for each of the assemblies are available from the factory. Each kit contains all the parts and detailed instructions that are required for complete maintenance. All o-rings and gaskets that have been disturbed during the disassembly must be replaced during reassembly in order to insure safe, trouble free operation. Failure to replace these parts could result in a shortened operation period and bodily injury.

5.1.1 Replacing the Inlet Capsule - Refer to Figure 3

a. Remove the two (2) body plate screws holding the body plate to the vacuum regulator body.

b. Pull the entire yoke assembly from the vacuum regulator body. A clockwise rotation will aid when the o-ring seal is tight. If the yoke assembly is the offset type, it contains an extra lead gasket connection (one at the vacuum regulator and one at the inlet valve). (Refer to Figure 8)

c. Remove the retaining clip and slide the inlet capsule out of the yoke assembly.

d. Remove filter and screen, and while depressing the vent plug, swish the capsule in alcohol to dislodge any accumulated debris. Reinsert the screen and replace fresh filter floss in like amount that was removed.

Note: Depending on the success of the cleaning operation, a new inlet capsule may be required.

e. Reassemble as follows:

f. Insert the inlet capsule and secure with the retaining clip.

g. Insert the yoke assembly in the vacuum regulator body using a clockwise rotation. A small film of Fluorolube™ grease on the inlet capsule o-ring is recommended.

h. Install the two (2) plate screws holding the body plate to the vacuum regulator body.

5.1.2 Cleaning the Metering Tube

a. Use a coin or washer as a screw- driver and loosen the bottom meter inlet plug while holding the flowmeter assembly to make sure it does not drop out. It may be necessary to use pliers if the plug has not been removed for some time.

b. Loosen the meter inlet plug about three (3) turns and remove the metering tube.

c. Bend a paper clip or wire and pull out the end stops on each end of the glass tube. DO NOT LOSE THE METERING BALL OR END STOPS.

d. Clean the inside of the glass tube with a pipe cleaner using wood alcohol, a solvent, and rinse thoroughly with warm water. Clean the metering ball.

e. Thoroughly dry the glass metering tube. Re-assemble the meter stops and ball.

f. Re-install the metering tube by tightening the meter inlet plug making sure it is on center with the top and bottom meter gaskets.

NOTE: The meter gaskets can usually be reused. Turn the gaskets over for best results.

5.1.3 Cleaning the Rate Adjustment Valve

NOTE: For plugged vacuum regulators with remote meter panels refer to instruction manual 100.6015.

a. Unscrew the rate valve from the valve bonnet.

b. Remove valve bonnet from the top of the front body. The valve sleeve will come along with the valve bonnet. The valve sleeve and screen can be screwed apart.

c. Clean the rate valve, rate valve bonnet, valve sleeve and o-rings by immersing in alcohol or soapy water, and dry thoroughly with a clean cloth.

d. The rate valve o-rings may need replacing if scratched or bruised. The valve sleeve o-ring usually will not require replacing, even if flattened.

e. Inspect the rate valve opening in the front body and clean with a damp cloth if necessary. DO NOT use any sharp tools that may scratch the internal surface. Never use any solvent for cleaning the plastic, as it will soften. Wood alcohol, however, can be used successfully.

f. Apply a thin film of Fluorolube™ grease to the valve sleeve o-rings and slide the valve sleeve into the front body.

g. Insert the rate valve o-rings on the rate valve and re-install in the vacuum regulator.

5.1.4 Vacuum Regulator Disassembly

a. Disassemble the vacuum regulator as described in paragraphs b and c below.

b. Remove the six (6) screws which hold the body assembly together. Separate the front and back bodies.

c. Remove the front plate and seal cover that exposes the sealing diaphragm assembly. This diaphragm can be slipped out over the guide pin, freeing the complete inside main diaphragm assembly.

d. Examine the main diaphragms. It is normal for some wrinkles to be present. The main diaphragms are made of a special tough, gas-resistant material and failure is unusual.

e. Clean the parts using wood alcohol. **DO NOT USE A STRONG SOLVENT** on the plastic or it will soften.

f. Reassemble the unit by reversing steps 1-5, and check the following.

g. Ensure the relief spring is installed on the front side of the main diaphragm assembly.

h. Use a very thin film of fluorolube grease on the main diaphragm sealing surfaces.

I. Ensure the surfaces are free of nicks, dirt, and scratches.

j. Use the seal cover as a centering guide for the main diaphragm assembly.

k. Check the flow-line o-ring found between the bodies. This usually requires replacement.

NOTE: The most critical part of the assembly is the centering of the main diaphragm assembly. A centering tool is available from the Factory as part of Service Tool Kit BM-2236.

l. Reassemble using the six (6) screws to join the bodies.

m. Install the sealing diaphragm, the seal cover and the front plate.

n. Reassemble the other parts as described in Service sections 5.1.1-5.1.3.

5.1.5 Ton Container Yoke Assembly - Universal Conversion - Refer to Figure 7

The vacuum regulator is supplied with either a right or universal yoke assembly. Universal yoke assemblies can be used for either right or left mounted valves (See Figure 6). If the position of the Universal yoke requires changing, proceed as follows:

a. Shut down the gas feeder according to the procedures in the Shut-Down section.

b. Remove the vacuum regulator after ensuring that the container valve is closed tightly.

c. Remove the two (2) hex bolts (N-381) holding the yoke assembly to the inlet adapter and remove the yoke assembly. See Figure 7.

d. Remove the G-111 lead gasket from the inlet adapter.

e. Re-assemble the yoke assembly on the opposite side of the inlet adapter using a new lead gasket (G-111). Replace the two (2) hex bolts (N-381) in the yoke assembly and tighten evenly to compress the lead gasket.

f. Mount the vacuum regulator on the ton container following the mounting procedures in Operation, Section D. Connect the drip leg pad heater to the power source.

g. Test for and correct any leaks following the procedures in the Start-Up section.

h. Resume operation.

5.2 Recommended Torque Values

The following torque values are used at the factory. These values are recommended guidelines for re-assembly of a repaired unit.

Back Body Screws (qty - 6) - 16 inch pounds

Body Plate Screws (qty - 2) - 16 inch pounds

Yoke assembly hex-head bolts - 8 foot pounds

Diaphragm front plate and back plate - 24 inch pounds

Yoke assembly to drip leg bolts - 96 inch pounds

Drip leg assembly to VR backing plate bolts - 5 foot pounds

6 TROUBLESHOOTING CHART

Avoid unnecessary disassembly of the unit. All of the units have been factory tested and calibrated before shipment.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
1. Gas Leak	There are few possible point of gas pressure leaks. These are not normal but if a gas leak is detected, it must be corrected immediately. Even a small leak can create a safety hazard and cause serious corrosion to other equipment. a. Gas leak at cylinder valve or isolating valve packing. b. Leak at lead gasket from dirt on the gasket, under or over-tightened connection, or installation without a gasket. c. Gas leaking out of the vent line may be from dirt on the vacuum regulator inlet valve seat (located in the inlet capsule). NOTE: The offset yoke and Universal ton yoke assemblies contain two (2) lead gasket connections. Be sure to check both.	a. Tighten the cylinder valve packing nut without exerting excessive force. If this does not eliminate the leak, close the valve and call the gas supplier. b. Use a new lead gasket each time the seal has been broken. Ensure the gasket surface is clean and smooth. c. Verify the leak by closing the water supply valve to the ejector, then submerge the end of the vent tubing in a glass of water. Continuous bubbling is an indication of a leak. Close the gas cylinder valve, turn on the water supply and allow the vacuum regulator to operate until the ball drops to the bottom of the metering tube. Keep the system operating for a few minutes to evacuate gas remaining in the system. Replace inlet capsule or clean the inlet valve seat. Refer to Service section 5.1.1
2. The required gas feed rate is not achieved at start-up.	a. Insufficient ejector vacuum due to insufficient water supply pressure for existing back pressure conditions. b. Leakage at vacuum line connections, vacuum regulator and/or inlet to ejector. c. Vacuum line(s) crimped d. Length of vacuum line(s) exceeds maximum allowable transport distance	a. Refer to Trouble 4. b. Inspect each connection and remake as necessary. c. Replace vacuum tubing and arrange line(s) to eliminate crimping. d. Refer to Bulletin 121.3003.
3. Out-of-gas indications occurs during normal operation	a. Gas supply valve(s) closed. b. Gas supply empty. c. Vacuum regulator inlet filter screen plugged. d. Gas supply indicator not reset.	a. Gas supply valve(s) closed. b. Gas supply empty. c. Vacuum regulator inlet filter screen plugged. d. Gas supply indicator not reset.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
4. Insufficient ejector vacuum.	a. Y-strainer in water supply line dirty. b. Back pressure is greater than the value listed for one of the following reasons: 1) solution valve, if supplied, not fully open; 2) solution line, if present, partially blocked; 3) back pressure at point of injection has increased above its original value. c. Ejector nozzle and/or throat dirty.	a. Clean Y-strainer b. Open solution valve; clean solution line; correct high back pressure condition c. Clean nozzle and/or throat, Refer to Ejector instruction manual 122.6006, or 122.6010.
5. Loss of gas feed.	a. Dirty or plugged ejector nozzle. b. Insufficient water pressure for ejector operation. c. No gas supply. d. Vacuum regulator inlet filter screen plugged	a. Clean ejector. Refer to Ejector instruction manual 122.6006 or 122.6010. b. Check and correct hydraulic conditions. c. Replenish gas supply. d. Clean the vacuum regulator inlet filter screen in hot, soapy water.
6. Flowmeter ball bounces and/or maximum gas feed rate cannot be achieved during normal operation.	a. Vacuum regulator inlet filter screen dirty. b. Rate valve dirty. c. Flowmeter dirty. d. Ejector water supply pressure fluctuating causing insufficient ejector vacuum. (Ball bouncing only)	a. Replace gas inlet filter screen and filter floss. b. Clean the rate valve. See Service section. c. Clean the flowmeter. See Service section and/or Remote Meter Panel instruction manual 100.6015. d. Check water supply pressure. Correct as necessary.
7. Flooded metering tube.	a. Dirt on the ejector check valve seat, or worn seat	a. Clean or replace ejector check valve seat. Refer to Ejector instruction manual 122.6006, 122.6010, or 122.6015. Disassemble and clean the vacuum regulator. The vacuum regulator will be full of chlorine solution.
8. Vacuum leaks	a. Rate valve o-rings worn b. Dirty main diaphragm or worn diaphragm back plate o-ring c. Dirty vacuum sealing o-ring. d. Dirty or worn inlet capsule o-ring.	a. Replace o-ring b. Clean or replace diaphragm and/or o-ring. c. Replace o-ring. d. Replace o-ring
9. Safety shut-off leak	a. dirty inlet capsule.	a. Clean inlet valve stem and seat.

Design improvements may be made without notice.

Represented by:

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CAPITAL CONTROLS

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A5300C

Instruction Manual — Automatic Switchover Module, Vacuum Type, 500 PPD Max (10 kg/h)

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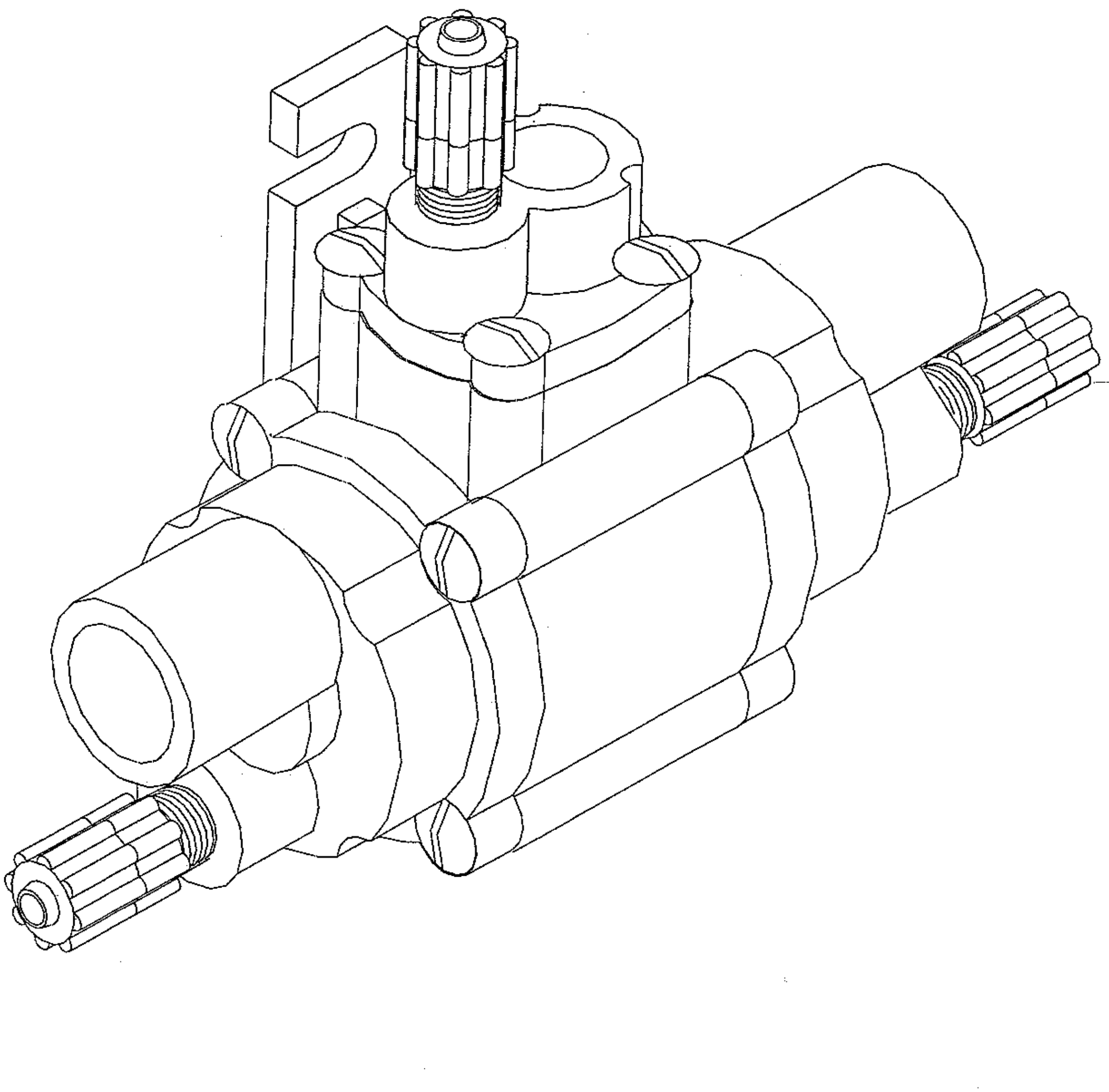

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call Severn Trent Water Purification for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. Severn Trent Water Purification, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact Severn Trent Water Purification, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into Severn Trent Water Purification equipment is conditioned on the customer absolving Severn Trent Water Purification from any consequences of such a decision.

Severn Trent Water Purification has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. Severn Trent Water Purification, Inc. cannot be responsible deviations from the recommended instructions that may result in a hazardous or unsafe condition.

Severn Trent Water Purification, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that Severn Trent Water Purification, Inc.

Severn Trent Water Purification, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped "F.O.B. Colmar" or to Severn Trent Water Purification for equipment shipped "F.O.B Jobsite". Do not install damaged equipment.

SEVERN TRENT SERVICES, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
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Table of Contents

1 INTRODUCTION

1.1 Principle of Operation (See Figure 1)

Each of two vacuum regulators with flow indicators are adapted to independent sources of gas under pressure. An automatic switchover module allows gas to flow under vacuum from the vacuum regulator in service to the flowmeter and rate control panel and the ejectors, until that source is depleted.

The vacuum sealing O-ring in the vacuum regulator then seals and the vacuum level increases, initiating the switching of toggle assembly in the switchover module. The open port on the depleted side of the switchover module closes, with the aid of a spring-loaded toggle assembly, while the closed port on the standby source opens to permit gas to flow.

When the operator replaces the depleted source, the fresh source is placed on automatic standby. The module will not access the fresh supply until the supply in service is exhausted.

1.2 Module Gas Capacity

Chlorine or Sulfur Dioxide Gas	Anhydrous Ammonia Gas
100 PPD (2 kg/h)	50 PPD (1 kg/h)
200 PPD (4 kg/h)	100 PPD (2 kg/h)
500 PPD (10 kg/h)	250 PPD (5 kg/h)

1.3 Component Description

The components of the vacuum type automatic switchover system include:

1.3.1 Two (2) gas vacuum regulators each equipped with gas flow indicators and served by an independent source of gas.

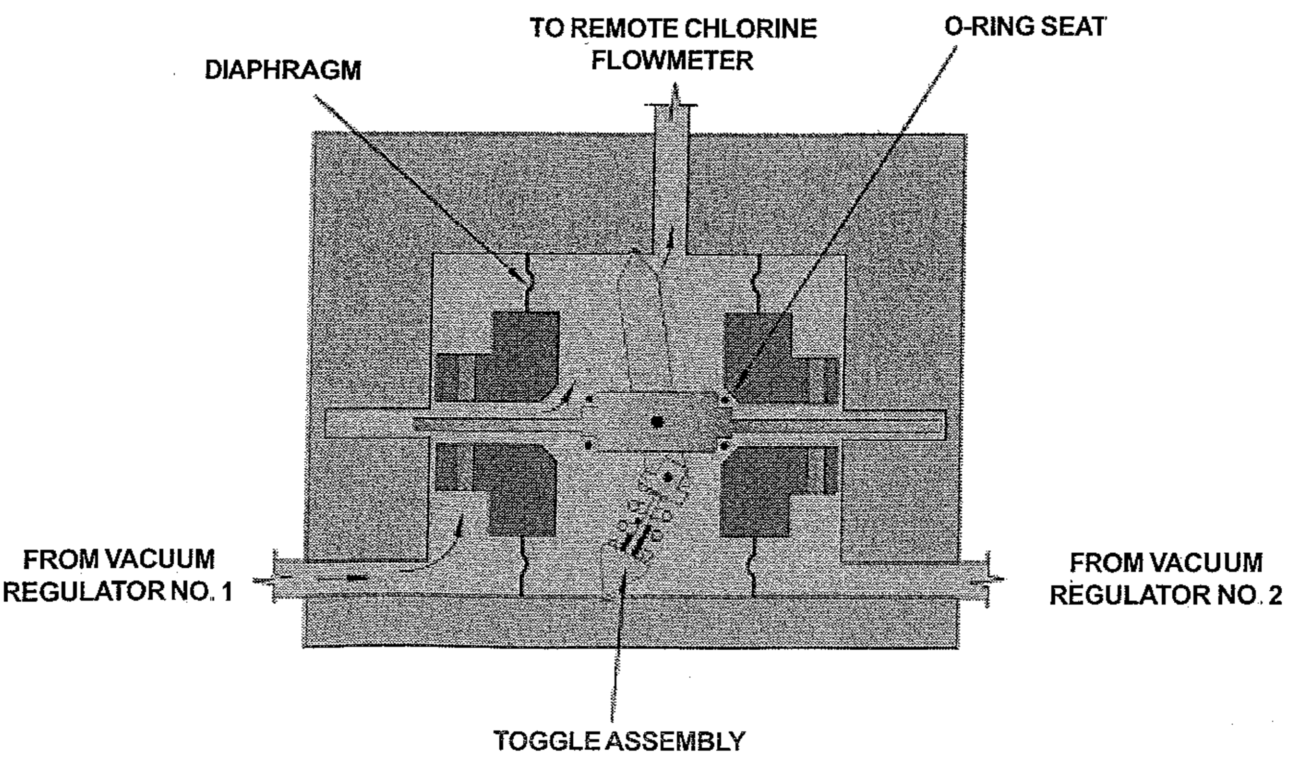

Figure 1 - Flow Diagram

1 3.2 One (1) vacuum type automatic switchover module having two inlets (one gas inlet from each vacuum regulator) and one vacuum outlet

1 3.3 A vacuum producing device (ejector or chemical induction unit [CHLOR-A-VAC]) via a flowmeter with rate adjustment. The gas from the switchover module can be distributed to multiple ejectors via multiple metering and rate controls.

NOTE: These instructions are applicable to the switchover module only. Other components are described in separate instruction manuals

2 INSTALLATION

2.1 General

The principle by which the automatic switchover module operates does not permit the use of a variable restriction, such as a rate valve, in the vacuum lines on the inlet sides. The vacuum regulators are therefore furnished with a plugged rate valve and gas flow indicators.

The gas flow rate is set and indicated by one or more panel or cabinet mounted rate valves and flowmeters inter-connected in the vacuum line between the discharge from the switchover module and the ejector(s). See Figures 2 and 3.

NOTE: When using a vacuum manifold system where two or more vacuum regulators are manifolded together on either side of a switchover module, the vacuum regulator's will be provided with rate valves. These rate valves are used to trim the vacuum regulator at full capacity. (Reference 121.3004)

2.2 Mounting (See Figure 4)

2.2.1 Mount the switchover module to a wall, cylinder scale, manifold or other fixed vertical surface.

2.2.2 Connect a length of tubing from each gas inlet of the automatic switchover module to the gas outlet on the two (2) vacuum regulators.

NOTE: When cutting the tubing, be sure to have enough length to allow the vacuum regulator to be moved when changing cylinders.

2.2.3 Connect a length of tubing from the gas outlet of the automatic switchover module to the gas inlet of the gas flow rate control.

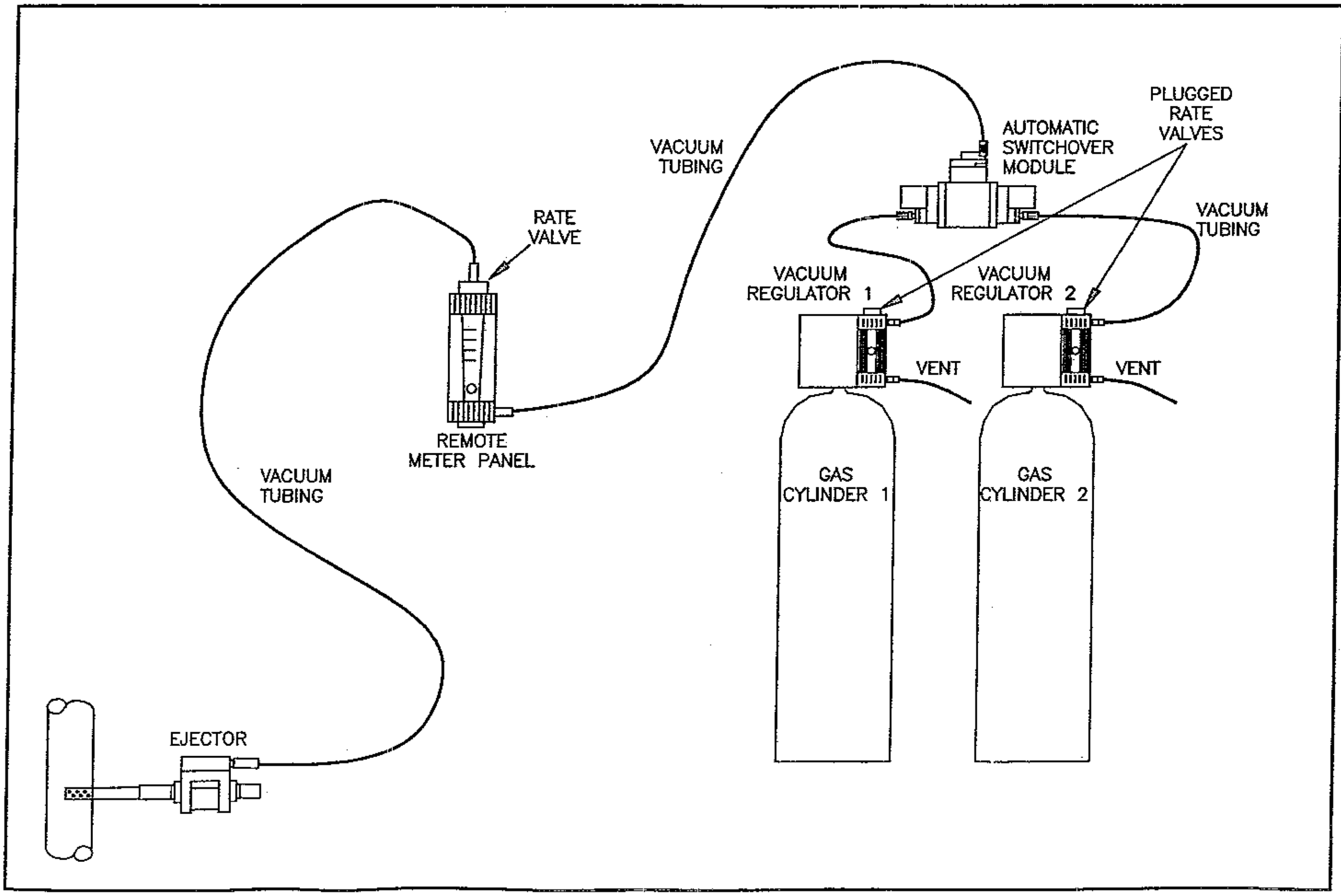

Figure 2 - Cylinder Mounted Automatic Switchover System

2.2.4 Connect a length of tubing from the gas outlet of the gas flow rate control to the inlet of the ejector.

General Design Note: Routing vacuum tubing through unventilated conduit is discouraged. A minute portion of gas flowing through tubing under vacuum conditions, will slowly diffuse at a molecular level through its walls and collect in the closed conduit over an extended period of time

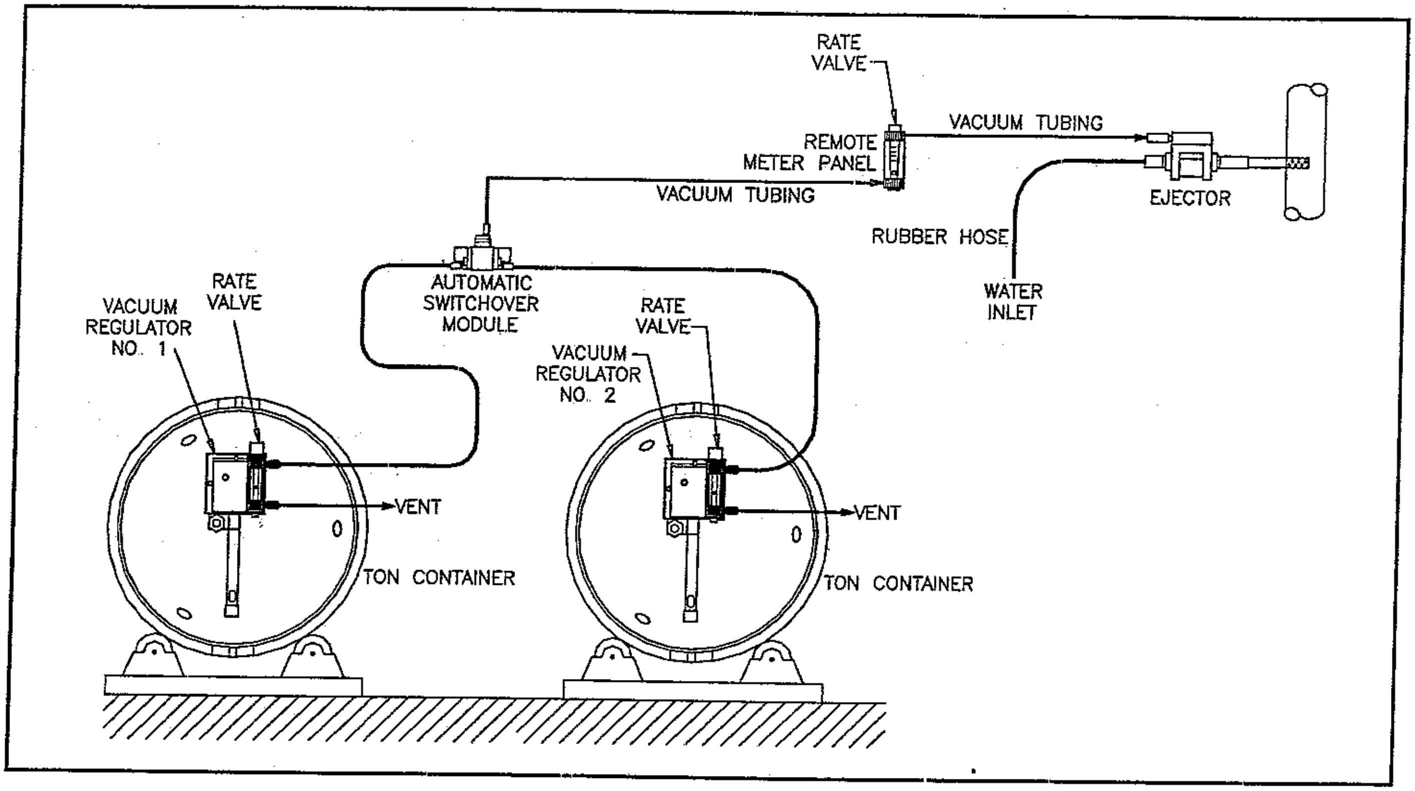

Figure 3 - Ton Container Mounted Automatic Switchover System

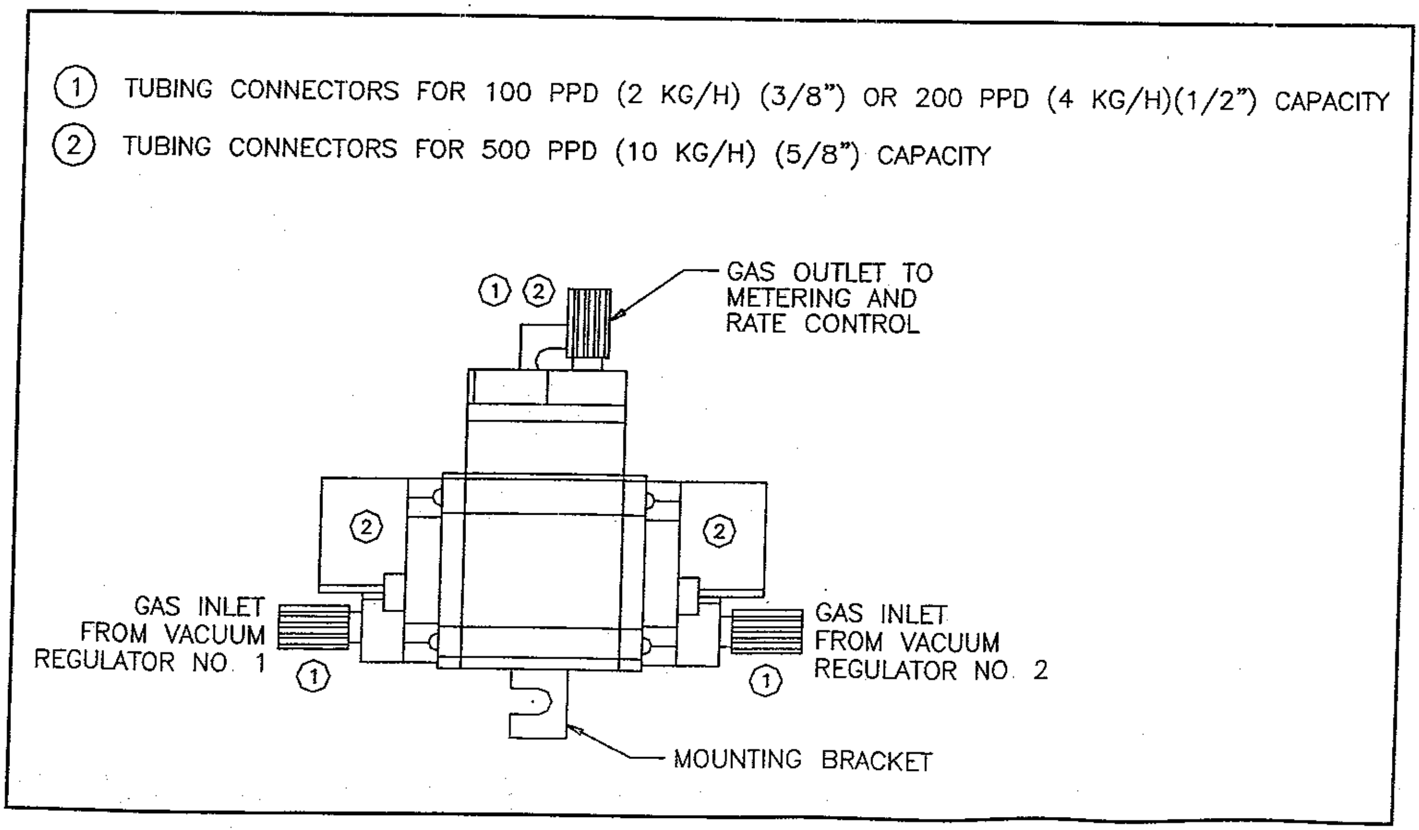

Figure 4 - 100 to 500 PPD (2 to 10 kg/h) Automatic Switchover Module

3 OPERATION

3.1 General

The automatic switchover module does not require any adjustment. For operating instructions on other system components, refer to the appropriate instruction manuals.

3.2 Start-up

3.2.1 After installation of all components, turn on the water supply to the ejector, or one ejector in a multiple ejector installation or chemical induction unit (CHLOR-A-VAC), to create an operating vacuum.

3.2.2 Test for gas leaks as described in the vacuum regulator instruction manual.

3.2.3 Open both gas source valves.

3.2.4 Close the gas source valve supplying vacuum regulator #1. This should cause the module to transfer feed to vacuum regulator #2. Vacuum regulator #1 should indicate out-of-gas at the vacuum regulator.

3.2.5 Open the gas source valve supplying vacuum regulator #1 and close the gas source valve supplying vacuum regulator #2. This should return gas feed to vacuum regulator #1 and should indicate out -of-gas at vacuum regulator #2.

3.2.6 Open both gas source valves, and proceed with normal operation.

3.3 Low Capacity

When the supply pressure is depleted, vacuum will build up and switchover will initiate. The rate at which vacuum builds after a gas supply is exhausted in one source is dependent upon two factors:

3.3.1 The volume, length and size of the vacuum lines which extends from the vacuum regulator to the ejector(s).

3.3.2 The gas feed rate.

The larger the vacuum line volume and the lower the gas feed rate, the slower the automatic switchover will function. It may be necessary, in systems feeding at a rate of less than 10 PPD (200 g/h) (chlorine or sulfur dioxide) and 5 PPD (100 g/h) (ammonia) to exercise the switchover module weekly to assure switchover operation and prevent sticking on both sides opening. This is accomplished by repeating steps 3.2.4 and 3.2.5

3.4 Capacity Conversion

If the gas flow requirements change to exceed the design capacity, it is usually possible to achieve the new requirements by substituting resized parts, provided the new requirements are within the maximum capacity of the components. The equipment that may require modification includes:

Vacuum regulators

Switchover module

Gas flowmeter and rate valve

Ejector

Interconnecting vacuum lines

Consult Capital Controls or your local sales representative to determine the extent of the modifications

4 SERVICE

The modular automatic switchover system is designed to give years of excellent service and will require minimum maintenance if operated with reasonable care. It is recommended that the Gas Dispensing System be inspected and serviced a minimum of once per year.

More frequent service periods may be required due to: 1) the type, quality and quantity of the gas being handled, 2) the complexity of the gas supply system and 3) operation procedures.

More frequent service periods are especially indicated when venting of the VR is occurring during the one year operational period. This is usually indicative of foreign debris holding the inlet valve open or destruction of the inlet valve parts caused by the gas quality not up to industry purity standards.

Preventative maintenance kits for each of the assemblies are available from the factory. Each kit contains all the parts and detailed instructions that are required for complete maintenance. All o-rings and gaskets that have been disturbed during the disassembly must be replaced during reassembly in order to insure safe, trouble free operation. Failure to replace these parts could result in a shortened operation period and bodily injury.

4.1 Cleaning the Module (Refer to Figure 5)

4.1.1 Shut down the system and evacuate all gas. Refer to the vacuum regulator instruction manual.

4.1.2 Remove the switchover module from the system. The gas dispensing system can be temporarily restored to operation by installing a length of vacuum line in place of the switchover module. Alternately, if the switchover system was installed with a valved bypass around the switchover module, open and close the appropriate valves before removing the module.

4.1.3 Remove the four (4) screws or bolts securing the toggle cap to the module.

4.1.4 Remove the four (4) screws holding each end body flange to the center body and remove the end body flanges and diaphragm assemblies.

4.1.5 Remove the toggle assembly

4.1.6 Remove the spring to the assembly and examine the guide pin. It should be free of dirt and burrs. If not, clean with alcohol and/or polish lightly with crocus cloth. It should then slide freely when straight and free of dirt.

4.1.7 Examine the O-ring seats in the diaphragm assemblies. They should be free of residue. If not, clean with alcohol. DO NOT use a sharp instrument to clean.

4.1.8 Examine the O-rings. If they are hardened or distorted, replace.

4.1.9 Reassemble the module, reversing steps 4.1.2-4.1.6. Be certain the spring pivot knife edge is seated in the slot in the toggle cap before it is tightened.

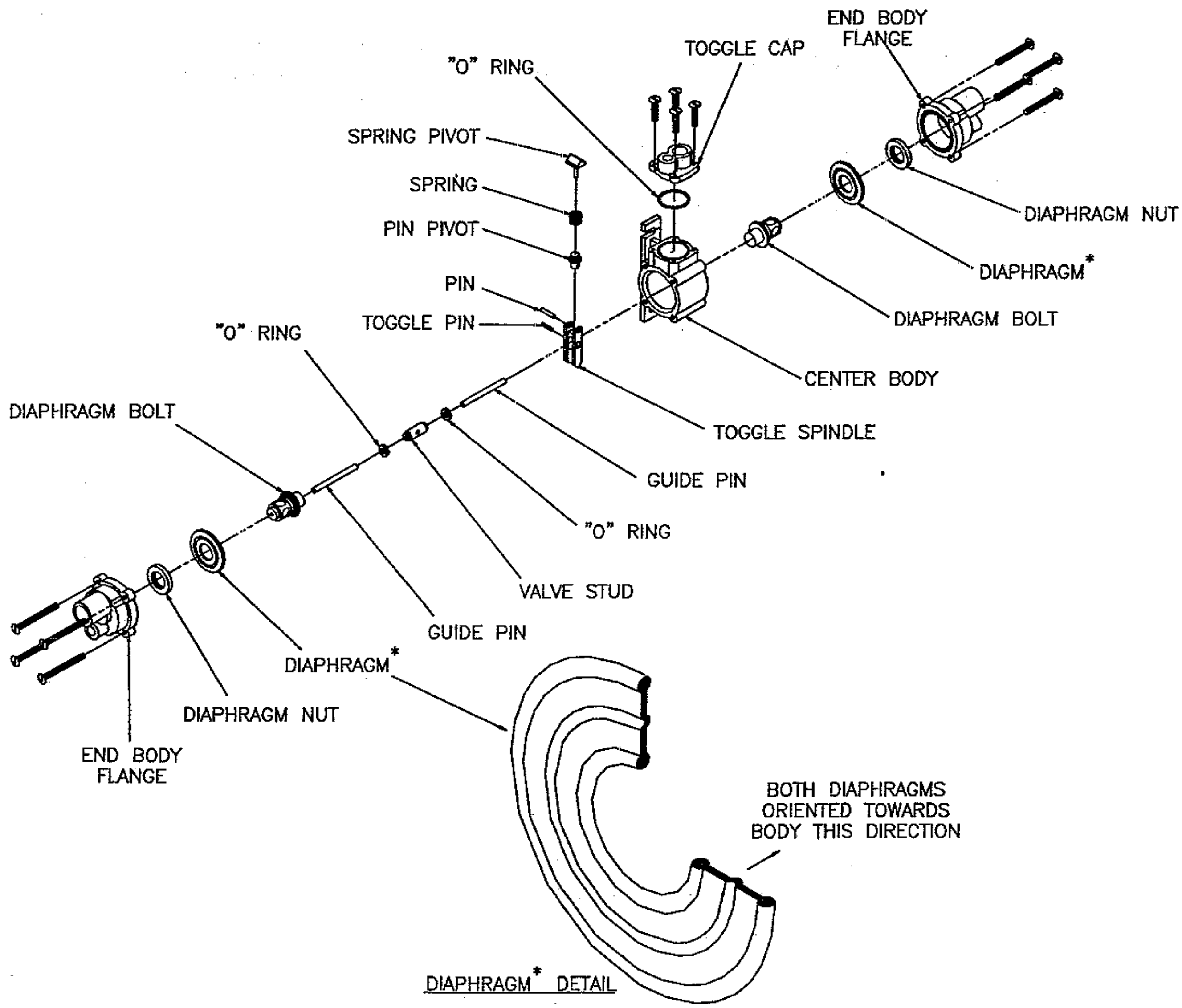

Figure 5 - 100 to 500 PPD (2 to 10 kg/h) Automatic Switchover Module Components

5 TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
1. Automatic switchover does not occur.	a. System is not entirely vacuum tight. b. Lack of ejector vacuum. c. Both gas supply valves are not open and second source is full. d. Module dirty.	a. Check system for vacuum tight integrity by following vacuum test procedure in appropriate instruction manual. b. Confirm ejector hydraulic conditions. c. Open both gas supply valves and ensure that the second gas supply is available. d. Clean the module, See Service Section.
2. Gas is being withdrawn from both sources simultaneously.	a. Module dirty.	a. Clean the module. See Service Section.
3. Switchover occurs before the first source is empty.	a. System feed rate exceeds available gas withdrawal rate from gas supply causing a pressure drop in the supply, simulating a depleted supply therefore, causing premature switchover. b. Vacuum regulator inlet filter is dirty and flow of gas cannot be achieved.	a. Increase the air temperature and air circulation around the gas supply to permit withdrawing the gas at the desired rate without causing a pressure drop switching the gas supply. Do not apply heat directly. b. Clean or replace the inlet filter.

NOTE: Premature switching from a supply not yet depleted because of high withdrawal rates (that causes a pressure drop simulating an empty supply) may not be objectionable. Allow the system to operate from the stand-by source as the first source will regain pressure as its heat is replenished from the atmosphere. When the second container empties or pressure decreases, the system will switch back to the first source.

Design improvements may be made without notice

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CAPITAL CONTROLS

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Vacuum Operated Automatic Switchover Module 500 PPD (10 kg/h) Maximum, Chlorine/Sulfur Dioxide 250 PPD (5 kg/h) Maximum, Ammonia

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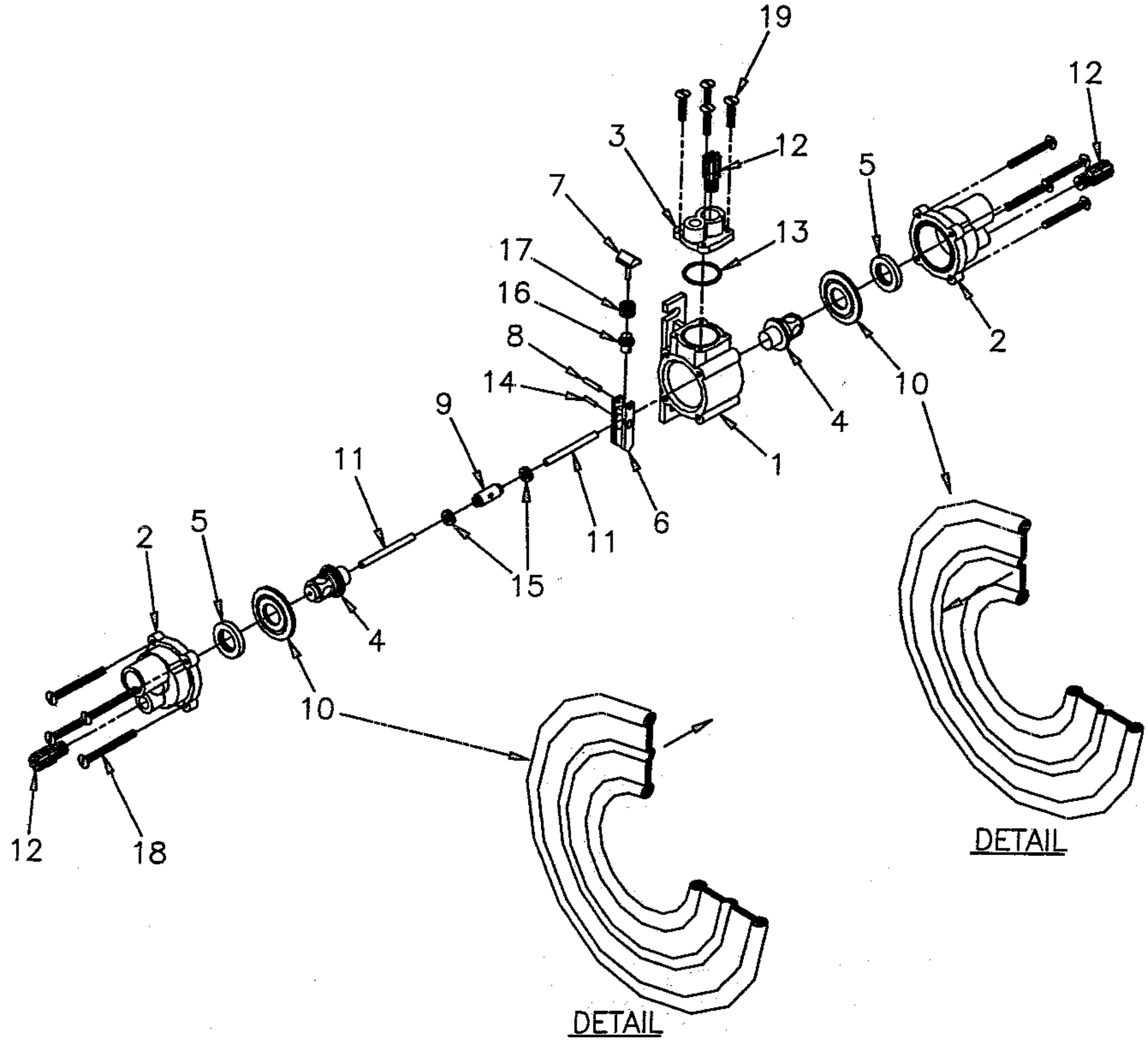
Disinfection Products



See reverse side for parts description

KEY NO.	QTY	DESCRIPTION	CHLORINE	SULFUR DIOXIDE	AMMONIA
1	1	CENTER BODY	U-808	U-808	U-808
2	2	END BODY FLANGE	SEE CHART	SEE CHART	SEE CHART
3	1	TOGGLE CAP	SEE CHART	SEE CHART	SEE CHART
4	2	DIAPHRAGM BOLT	U-627	U-627-1	U-627
5	2	DIAPHRAGM NUT	U-1683	U-917-1	U-1683
6	1	TOGGLE SPINDLE	U-751	U-751	U-751
7	1	SPRING PIVOT	A-277	A-277	A-277-1
8	1	PIN	W-176	W-176	W-176-1
9	1	VALVE STUD	U-628	U-628	U-628
+ 10	2	DIAPHRAGM	D-104	D-104	D-104-2
11	2	GUIDE PIN	W-196	W-196	W-196-1
12	3	TUBING CONNECTOR	SEE CHART	SEE CHART	SEE CHART
+ 13	1	O-RING	OV-11-028	OV-11-028	OA-11-028
14	1	TOGGLE PIN	W-168	W-168	W-168-1
+ 15	2	O-RING	OV-11-203	OV-11-203	OA-11-203
16	1	PIN PIVOT	U-513	U-513	U-513
17	1	SPRING	S-125	S-125	S-125
18	8	1/4-20 X 3/4 INCH LG END FLANGE SCREW	N-189	N-189	N-189
19	4	10-24 X 1/2 INCH LG TOGGLE CAP SCREW	N-138	N-138	N-138

CAPACITY IN PPD (KG/H)		KEY NO.			
				12	
AMMONIA	CHLORINE/ SULFUR DIOXIDE	2	3	CHLORINE/ AMMONIA	SULFUR DIOXIDE
50 (1)	100 (2)	U-809	U-810	F-100	F-100-1
100 (2)	200 (4)	U-809	U-810	F-106	F-106-1
250 (5)	500 (10)	U-811	U-812	F-116-1	F-116-1

NOTES:

1. (+) INDICATE PARTS INCLUDED IN MAINTENANCE KITS.
ADDITIONAL PARTS AND QUANTITIES SHOULD BE CONSIDERED WHERE THE EQUIPMENT IS USED TO ITS FULLEST CAPABILITY OR WHERE LOCATED IN AN AREA REMOTE FROM CONVENIENT SERVICE.

TO ORDER A PREVENTIVE MAINTENANCE KIT, PARTS INDICATED BY (+) ORDER:

CHLORINE OR SULFUR DIOXIDE--------14428
AMMONIA-----------------------14429

2. WHEN ORDERING PARTS, SPECIFY THE GAS, FEEDER CAPACITY, SERIAL NUMBER, AND MODEL NUMBER.

USING PARTS OTHER THAN GENUINE STWP PARTS:

- CAN RESULT IN MALFUNCTION OF THE EQUIPMENT AND POTENTIALLY CAUSE SERIOUS PERSONAL AND ENVIRONMENTAL HEALTH AND SAFETY HAZARDS
- WILL VOID YOUR EQUIPMENT WARRANTY
- WILL VOID YOUR LIABILITY CLAIMS TO STS

Severn Trent Services
3000 Advance Lane
Colmar, PA 18915 USA
Tel: 215-997-4000, Fax: 215-997-4062
Service Hotline: 800-523-6526

Warranty Policy for
Severn Trent Water Purification, Inc.
Products & Services

SEVERN
TRENT
SERVICES

Disinfection Products

1. **Scope of Warranty**
Severn Trent Water Purification, Inc. ("STWP") warrants to the original buyer, products that have been purchased for the purpose identified in our literature. Any warranty granted is void if products are used in any other manner. The Severn Trent Water Purification, Inc. products covered are:
   - Gas dispensers for Cl2, SO2, NH3 and CO2 service, including related accessories, controls and safety equipment/instrumentation.
   - Analytical Instrumentation & Water Quality Instrumentation.
   - Gas Feed Systems (custom engineered equipment).
   - Parts and Consumable Products for all the above products.
   - UV Disinfection

2. **Standard Warranty**
The standard warranty for Severn Trent Water Purification, Inc. products is detailed in the company's "Terms and Conditions of Sale" (Document # 005.9000), which is the governing document for STWP Warranty Policy. In brief, this states that all warranties cover only material non-conformities or workmanship occurring in the course of manufacturing (not maintenance), and require return to the factory with transportation charges prepaid by the Buyer. More specifically:

   A. **Products - Equipment that is listed in Severn Trent Water Purification, Inc. literature.**
   These products are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning, whichever expires first. (See also Section 3 below.)

   B. **Spare and/or Replacement parts**
   Spare and / or replacement parts are warranted for twelve (12) months from the date of factory invoice

   C. **Consumable Products**
   Products (including chemical reagents) that are depleted during use and/or are date sensitive are considered Consumable Products. Consumable Products are to be stored and used according to STWP literature. Consumable Products are warranted against defects in material, formulation and workmanship occurring in the course of manufacturing up to the expiration and/or "use by" date. Instrument probes are warranted for a period of ninety (90) days from the date of factory invoice. To substantiate a failure in warranty, claimant must provide detailed information to the STWP factory. Any warranty granted by STWP is void if Consumable Products are used on products other than Severn Trent Water Purification, Inc. Also, if other than Severn Trent Water Purification, Inc. products are used on Severn Trent Water Purification, Inc. instruments, this may void the warranty.

   D. **Equipment Manufactured by Others**
   Products purchased from another manufacturer and supplied by STWP for the convenience of the customer, or as part of a system, carry the warranty of the original manufacturer. The customer should contact the original manufacturer directly about warranty issues; or STWP, upon request, will act as an agent when dealing with warranty issues. If STWP acts as an agent the customer must return equipment to the designated factory, shipping charges pre-paid. Customers' sole remedy is the original equipment manufacturer's warranty.

   E. **Systems - Custom Engineered Equipment**
   STWP warrants all products that are integrated and arranged into a system (which conform to the functional intent of the customers specifications and has been approved by the customer) for performance to Severn Trent Water Purification, Inc. documented specifications. This warranty is for material defects in components and workmanship occurring in the course of our manufacturing.

   All material defects in components and workmanship occurring in the course of commissioning and start-up not performed by STWP are not covered under this warranty. These systems are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning (requires written notice of customer's acceptance of product), which ever expires first. The claimant must provide written notice (including details of functional operation during failure) of any defect(s) to substantiate the failure in warranty to the STWP factory.

F. Field Service

STWP warrants all start-up work performed by our Field Service personnel for the same duration as our product and/or system warranty for material defects in components and workmanship occurring in the course of our work, but not the product or system application.

Customer is responsible for operating, maintaining (including changing consumables), and calibrating the product and/or system as described in the manual(s) provided by STWP.

All maintenance and/or repair performed by Severn Trent Water Purification, Inc. Field Service is warranted for a period of one-hundred and twenty (120) days from the date of service, or until the end of the original warranty period if service is performed during the warranty period, whichever is longer.

G. Factory Repair

STWP warrants that all factory repairs made to a product, under customer purchase order or warranty, will operate within documented technical specifications for a period of one-hundred and twenty (120) days from date of shipment, or until the end of the product's original warranty period, whichever is longer.

3. __Extended Product Warranty__

A. Series 200, Model 480 and Series NXT3000

The Vacuum Regulator ("VR") and Meter Assemblies within individual 200, 480 and NXT3000 chlorinators, ammoniators, carbonators or sulfonators with the original serial number intact are warranted for thirty-six (36) months from the date of factory invoice against defects in material and workmanship occurring in the course of manufacturing. (This extended warranty does not apply to Ejector assemblies.) The following parts incorporated in the Series 200, Model 480 and Series NXT3000 Vacuum Regulator assembly carry a Lifetime Warranty against any defects in material and workmanship:

Series 200 & Model 480 Series NXT3000-

Springs-Hastelloy C Inlet Body and Spring-Halar Diaphragm-Halar Diaphragm

4. __Important Notes__

STWP may require the return of defective/non-conforming products to its factory for examination and testing to verify non-conformity. A confirmed non-conformity, within the applicable warranty period, will be repaired or replaced as determined by STWP. Warranty does not include any installation, removal or freight expenses that might be associated with warranty repair or replacement.

In situations where STWP agrees that it is not feasible for the claimant to return equipment to the factory, a purchase order will be required to dispatch a Service Technician and the claimant will only be invoiced if the product is found to be not warrantable.

STWP will make no allowance or reimbursement for repairs, alterations, replacements, or work of any kind done or ordered by others without prior written authorization by STWP.

The original buyer's sole remedy for breach of warranty for a product and/or service shall be at STWP's sole option to either repair or replace non-conforming product and/or service. If required, after evaluation and determination that a product is non-conforming by reason of manufacturing, STWP can refund the original buyer's purchase price for such product or service. Design improvements may be made without notice

Design improvements may be made without notice.

Represented by:

SEVERN TRENT SERVICES

Severn Trent Services
3000 Advance Lane Colmar, PA 18915
Tel: 215-997-4000 • Fax: 215-997-4062
Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

Decontamination Certificate

SEVERN TRENT SERVICES

Disinfection Products

THE FOLLOWING CLEANING PROCEDURES (SEE PAGE 2) MUST BE IMPLEMENTED AT THE CUSTOMER'S EXPENSE IF THE EQUIPMENT IS TO BE RETURNED TO THE FACTORY FOR SERVICE.

This sheet must be attached to the outside of each (if more than one) shipping carton, along with any applicable MSDS health/material handling recommendations.

FAILURE TO PROPERLY CLEAN THE EQUIPMENT OR ATTACH THE DECONTAMINATION CERTIFICATE TO THE OUTSIDE OF THE CARTON WILL RESULT IN THE EQUIPMENT BEING RETURNED UNREPAIRED.

Decontamination Statement

RA Number (WARRANTY & CREDIT RETURNS ONLY): ______________________________

Equipment to be returned: ______________________________

Model #: ______________ Serial #: ______________ PO#: ____________ Date of PO: ____________

Application: ☐ Waste Water ☐ Potable Water ☐ Industrial Process (MSDS Required)

List all chemical and process fluids in contact with the equipment.
Attach additional pages if necessary.

____

____

____

____

____

I hereby certify that the equipment being returned has been prepared for shipment and decontaminated in accordance with the procedure stated on page 2 of this document corresponding to the product that is being returned. The equipment is in compliance with OSHA and DOT regulations. This equipment poses no health or safety risks due to contamination.

By: ______________________________ ______________________________
(Signature) (Please Print)

Title: ______________________________ Date: ______________________________

Company Name: ______________________________

Phone Number: ______________________________ Fax Number: ______________________________

Detailed Reason for Return: ______________________________

____

____

CHLOR-A-VAC

- Flush out the vacuum connection of any residue chemicals.
- Remove all treatment facility process solids adhering to the CHLOR-A-VAC unit (including the inside of the vacuum housing) and the power cord with a pressure washer.
- Scrub the CHLOR-A-VAC and the power cord using a 10% solution of household bleach. Rinse thoroughly with potable water.
- Pack with appropriate restraints and packing materials to prevent shipping damage.

Liquid Feed

- Liquid Dosing Systems - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.
- Chlorine Dioxide Generators (All-Liquid Systems only) - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets - For chlorine gas type generators, consult factory.
- Tablet Feeders - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.

Gas Feed

- Pull air through system for 15 minutes with rate valve fully open. Wipe down exterior surfaces.

Instrumentation

- Wipe down exterior surfaces.

Analyzers

- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Aztec Monitors

- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Utraviolet Equipment

- Remove all treatment facility process solids to the unit with a pressure washer. Wipe down exterior surfaces. Package lamps and quartz separately.

pH probes

- Rinse with potable water

Dissolved Oxygen Probes

- Rinse probe and container with potable water. Wipe down exterior surfaces. Pack probe in container with potable water.

EST Equipment - (Included but not limited to Eductors, Steam Jets/Vacuum Systems, Scrubbers and Desuperheaters.) Due to the vast range of individually specific applications, an all encompassing decontamination procedure cannot apply. For this reason the end user bears responsibility for specific decontamination procedures. As a minimum the following shall apply:

- Remove and neutralize all acids and bases or other corrosive contaminants.
- Thoroughly purge equipment of all poisonous or noxious chemicals and irritants.
- Remove all foreign material, precipitate, fouling, scale, residue and/or noxious odor.

After the above has been completed, the equipment should be thoroughly rinsed using clean water and a mild detergent and be completely dried prior to packaging for return.

Design improvements may be made without notice

Represented by:

SEVERN TRENT SERVICES

Severn Trent Services
3000 Advance Lane Colmar PA 18915
Tel: 215-997-4000 • Fax: 215-997-4062
Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

SEVERN TRENT SERVICES

Disinfection Products

Subject: Gas Feed Product Spare Parts

Dear Valued Customer,

As a user of Severn Trent Water Purification, Inc. products, you are a significant reason for the continued success of this company. All of us at STWP want to thank you for your business.

We appreciate this opportunity to present our views on "interchangeable" spare parts. Many of our smaller competitors, in an effort to gain market share, have developed "knock-off" spare parts for many of the products that we manufacture for gas feed applications. Since patent protection has expired, we have seen a significant attempt to flood the market with these "knock-off" parts.

Obviously, STWP wants to protect its' spare parts business but we feel that there are significant issues that you should consider.

We believe municipal procurement practices which call for sourcing from the lowest priced supplier serve the public well. But lower priced "knock-off" parts can seriously endanger the welfare of the public as well as your operators.

We are committed to providing the highest quality parts at competitive prices. As a manufacturer of gas feed equipment with over 45 years of experience, we have an enviable safety record. This record has been earned through meticulous attention to design, materials and quality. You may not know that we pioneered the all-vacuum method of gas feed and that we have been certified to the worldwide ISO 9001 quality standard since 1991.

Using parts other than genuine STWP parts:

- ***can result in malfunction of the equipment and potentially cause serious personal and environmental health and safety hazards***
- ***will void your equipment warranty***
- ***will void your liability claims to STWP***

We are extremely concerned about these issues and believe you are as well. Our recommendation is that your procurement policy for gas feed parts and equipment require that:

- ***replacement/spare parts always be sourced from the original manufacturer, and***
- ***you have evidence of substantial product liability insurance***

These measures preserve product integrity and safety, and your right of recourse in the event of an occurrence.

With the current public and various safety agency concerns, we strongly believe that these are critical issues for our industry, our customers and their employees.

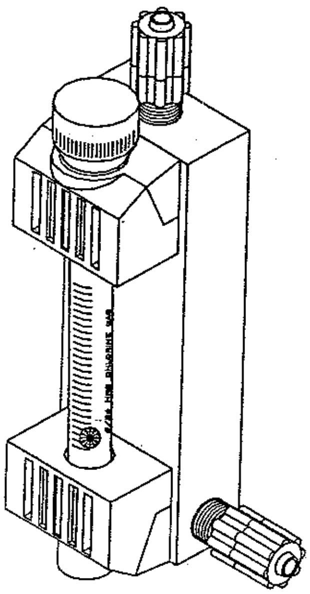
Should you have any questions or comments, I would very much like to hear from you. You can email me at jblundi@severntrentservices.com or call me at 215 997 4065

James R. Blundi
Director
Gas Feed and Instrumentation

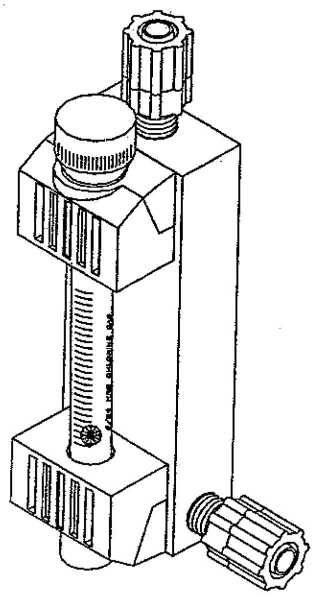
Instruction Manual — Series 200 Remote Meter Panels 500 PPD (10 kg/h) Maximum Capacity

SEVERN TRENT SERVICES

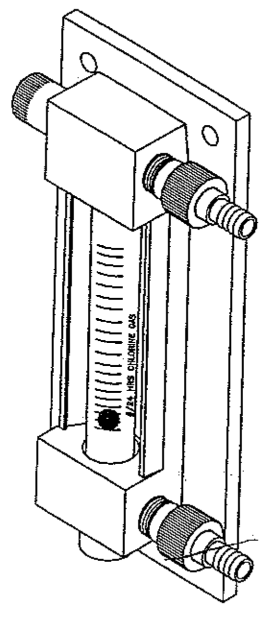
CAPITAL CONTROLS



100 PPD (2 kg/h) Maximum



200 PPD (4 kg/h) Maximum
(250 PPD [5 kg/h] Chlorine only)



500 PPD (10 kg/h) Maximum

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call Severn Trent Water Purification for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. Severn Trent Water Purification, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact Severn Trent Water Purification, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into Severn Trent Water Purification equipment is conditioned on the customer absolving Severn Trent Water Purification from any consequences of such a decision.

Severn Trent Water Purification has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. Severn Trent Water Purification, Inc cannot be responsible deviations from the recommended instructions that may result in a hazardous or unsafe condition.

Severn Trent Water Purification, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that Severn Trent Water Purification, Inc.

Severn Trent Water Purification, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped "F.O.B. Colmar" or to Severn Trent Water Purification for equipment shipped "F.O.B Jobsite". Do not install damaged equipment.

SEVERN TRENT SERVICES, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
IS ISO 9001: 2000 CERTIFIED

Table of Contents

1 INTRODUCTION

1.1 General

The ADVANCE® remote meter panels are expertly engineered and carefully tested to assure years of satisfactory operation. The meter panels are constructed of the finest materials available for gas service. Proper installation and care will ensure the best operation Read instructions carefully and retain for future reference.

These instructions cover Series 200 Remote Meter panels only. Refer to the following for other components:

Remote Meter Panel Dimensions - 100.3004

Vacuum regulator -100.6010

Ejector - 122.6005

Automatic Switchover -100.6030

1.2 Warranty and Service

See 005.9001 for ADVANCE® equipment warranty.

NOTE: The Series 200 Remote Meter Panel is designed for use with a Series 200 gas feeder. The ADVANCE® equipment warranty and service policy is null and void, as it pertains to user protection, if the Series 200 Remote Meter Panel is misapplied.

It is recommended that the Gas Dispensing System be inspected and serviced a minimum of once per year.

More frequent service periods may be required due to: 1) the type, quality and quantity of the gas being handled, 2) the complexity of the gas supply system, 3) the quality and quantity of water or process liquid being used to operate the ejector(s), and 4) operation procedures.

More frequent service periods are especially indicated when venting of the VR is occurring during the one year operational period. This is usually indicative of foreign debris holding the inlet valve open or destruction of the inlet valve parts caused by the gas quality not up to industry purity standards.

1.3 Remote Meter Panel Data

Capacity	Meter Tube Size	Capacities Available as Chlorine	Tubing Connection
100 PPD (2 kg/h)	3"	4, 10, 25, 50, 100 PPD (75 & 200 g/h, 0.5, 1, 2 kg/h)	Inlet - 3/8", 1/2", 5/8" Outlet - 3/8"
250 PPD (5 kg/h)	3"	25, 50, 100, 200, 250 PPD (0.5, 0.9, 2, 4, 5 kg/h)	Inlet - 1/2", 5/8" Outlet - 1/2"
500 PPD (10 kg/h)	6"	25, 50, 100, 200, 300, 500 PPD (0.5, 0.9, 2.0, 4, 6, 10 kg/h)	Inlet - 5/8" Outlet - 5/8"

Accuracy: 4% of maximum flowmeter capacity

1.4 Multiple Meter Panels

Multiple meter panels are available with up to four (4) meter. These meters are usually mounted on a panel with a common inlet block and individual gas flowmeter outlets. The multiple meter panels are used for the same gas only

2 OPERATION

2.1 General

The remote meter panel is designed to complement the Capital Controls' Series 200 vacuum regulators When multiple chlorine gas feed points from the same vacuum regulator are required, a remote meter panel is utilized. Each remote meter panel is manually set, via the rate valve, to meter the proper amount of chlorine gas to the feed point. The combined gas feed rate from the remote meters must not exceed the total feed rate capacity of the vacuum regulator.

NOTE: When remote meter panels are desired to be used for gas flow indication only , the rate valve at the vacuum regulator is used to adjust gas flow. Therefore, if the vacuum regulator has a rate valve, the remote meter's rate valve should be removed and replaced with a plug.

2.2 Installation - See Figures 1, 2, and 3

The remote meter panel must be installed in an upright and level position in order to function properly.

The remote meter panel is installed in the vacuum line between the ejector and the vacuum regulator. Locate the meter panel on a vertical surface convenient for observation and operation, usually in the operator's area, with the point of chlorine injection at the desired remote location. Mount the meter panel using two (2) 1/4" mounting screws for a 3" meter panel, or four (4) 3/8" mounting screws for a 6" meter panel. If the surface is not suitable for wood screws, choose an appropriate anchor bolt to that surface.

Black polyethylene tubing is normally used for the vacuum line. Do not kink this tubing. It may be desirable to use tubing connectors, tees or 90° elbows to provide as direct run as possible and minimize kinking conditions. Use enough tubing length to allow movement of the vacuum regulator for servicing or cylinder change. Connect the tubing as follows:

2.2.1 Remove the bottom vacuum inlet connector nut from the remote meter panel and slip the connector nut onto the vacuum tubing coming from the vacuum regulator.

2.2.2 Push the tubing onto the tubing connector and tighten the connector nut HAND TIGHT.

2.2.3 Remove the connector nut from the vacuum outlet (top) of the remote meter and slip onto vacuum tubing going to the ejector.

2.2.4 Push the tubing onto the tubing connector and tighten the connector nut HAND TIGHT.

NOTE: There may be installations where multiple meter panels may be used from one vacuum regulator. If this occurs, additional tees may be required to complete the installation.

2.2.5 Some meter panels may be provided as a complete block with a common vacuum manifold, Each meter would have an individual outlet.

General Design Note: Routing vacuum tubing through unventilated conduit is discouraged. A minute portion of gas flowing through tubing under vacuum conditions, will slowly diffuse at a molecular level through its walls and collect in the closed conduit over an extended period of time.

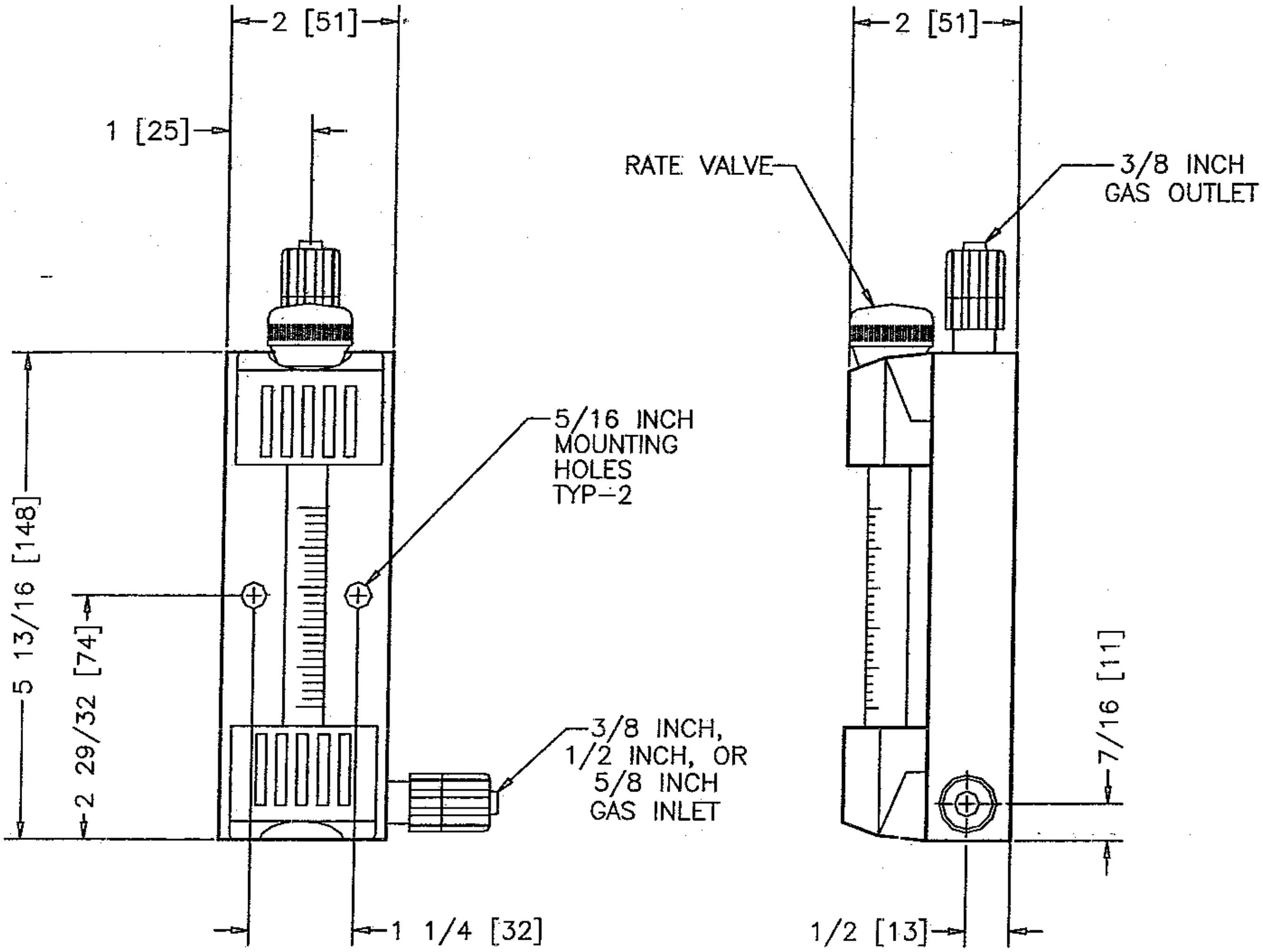


Figure 1 - 100 PPD (2 kg/h) Meter Panel

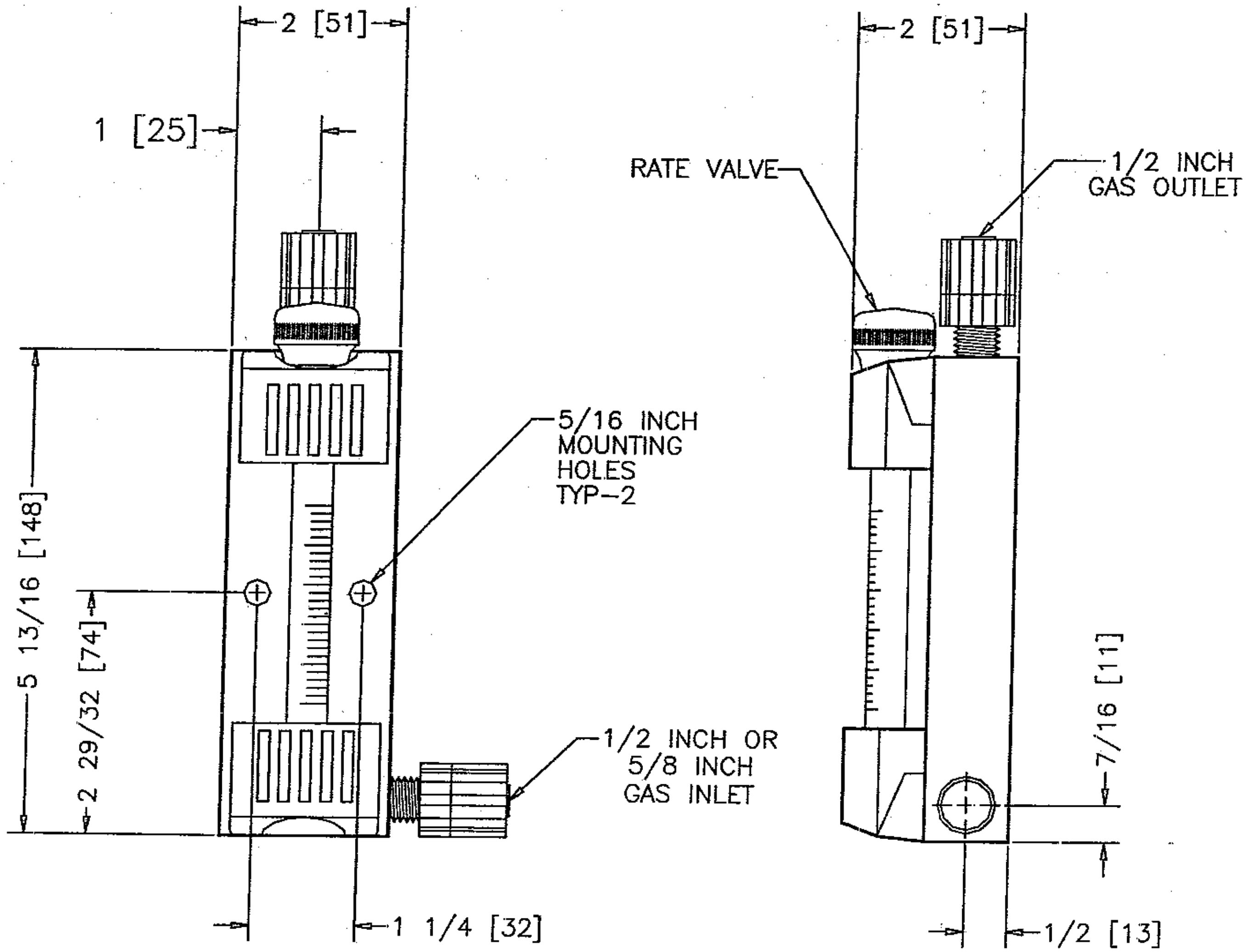


Figure 2 - 200 PPD (4 kg/h) Meter Panel

3 START-UP

Follow the instructions provided in the vacuum regulator instruction manual 100.6010 for complete system start-up procedures.

After the system has been tested for leaks and is operating, adjust the rate valve to the desired gas flow rate. The flow rates are in PPD (pounds per day) of chlorine.

If feeding sulfur dioxide, the actual flow rate is 0.95 of the scale value. For example, a reading of 50 PPD (1 kg/h) is actually 45 PPD (0.95 kg/h) sulfur dioxide.

If feeding ammonia, the actual flow rate is 0.50 of the scale value. For example, a reading of 50 PPD (1 kg/h) is actually 25 PPD (0.5 kg/h) ammonia.

Read the flowmeter scale at the center of the ball.

NOTE: NEVER use the rate valve on the remote meter panel to shut off the gas supply. This valve is for adjusting flow rate while the system is in operation. If used for shutoff, this valve will be damaged. To shut off the gas, close the gas container valve.

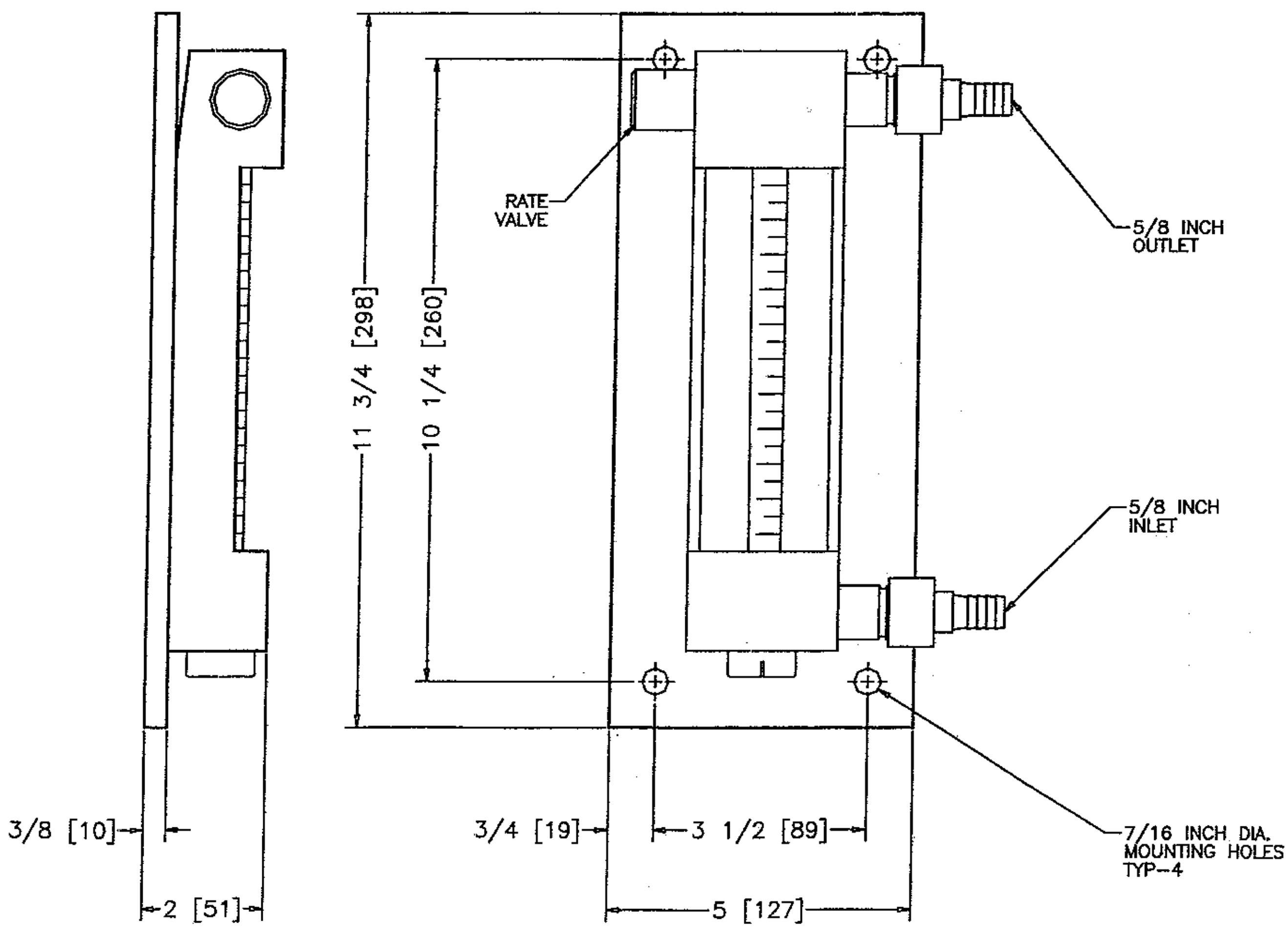


Figure 3 - 500 PPD (10 kg/h) Meter Panel
250 PPD [5 kg/h] & 300PPD (6 kg/h) Chlorine only)

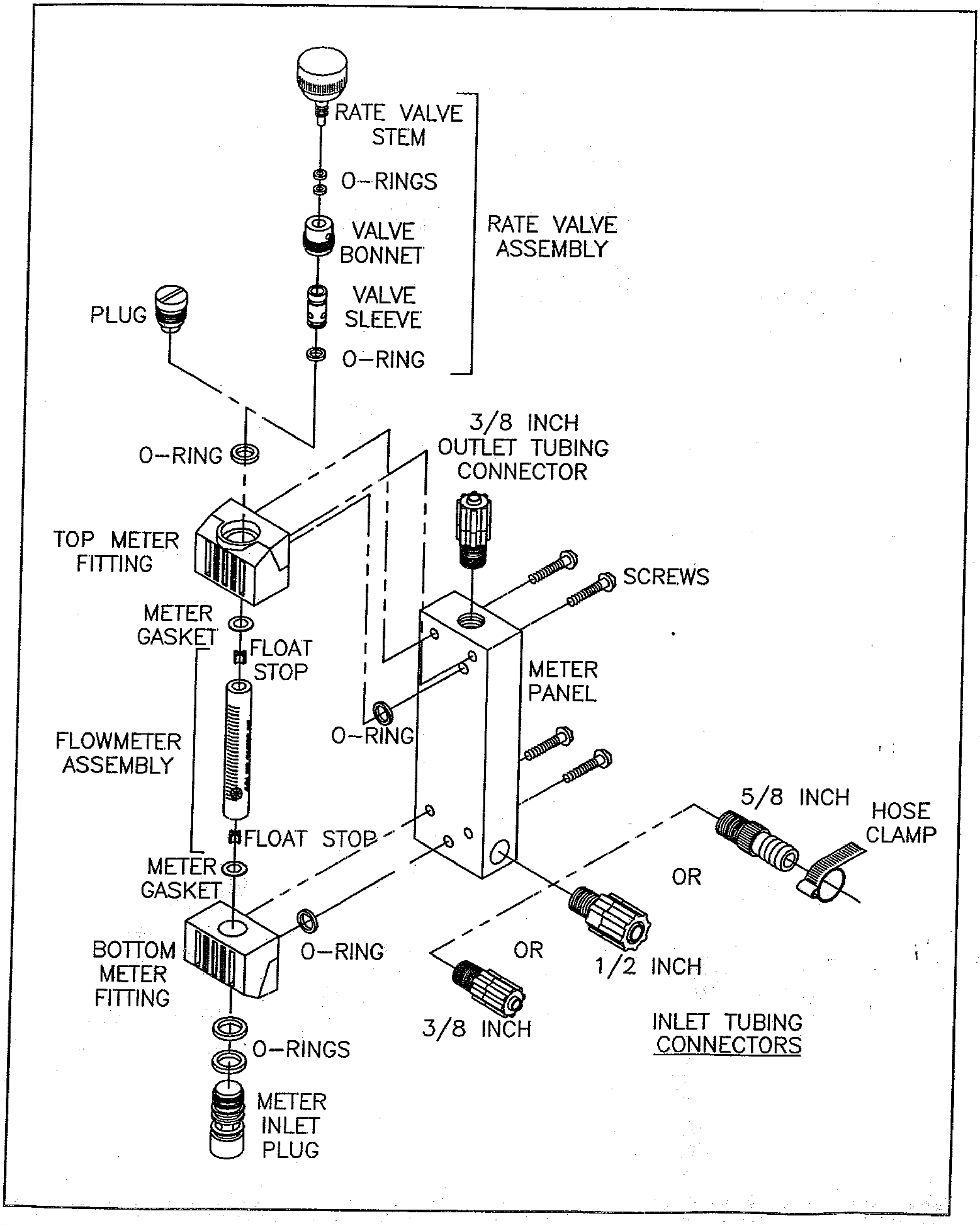


Figure 4 - 100 PPD (2 kg/h) Meter Panel Components

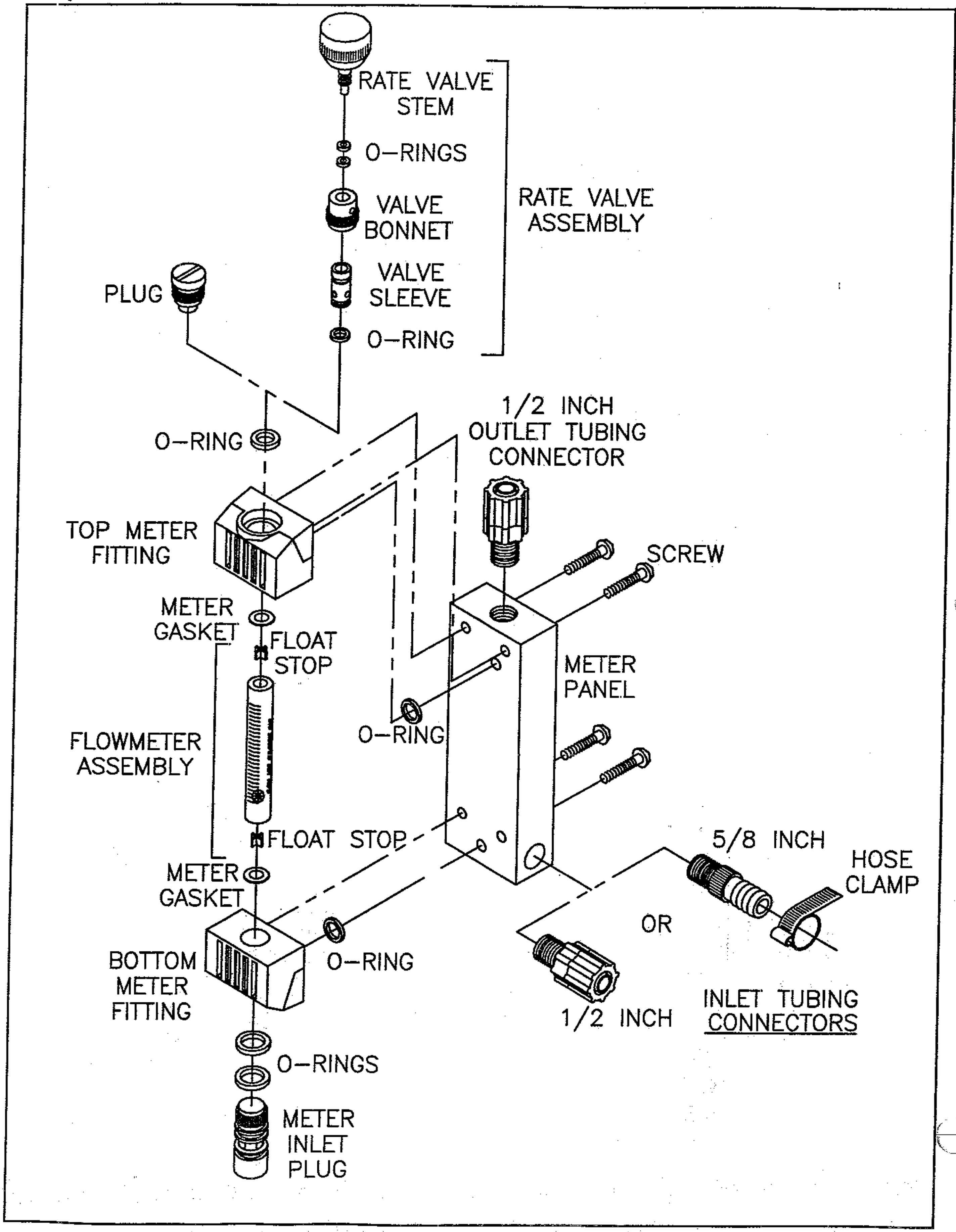


Figure 5 - 250 PPD Max (4 kg/h) Meter Panel Components

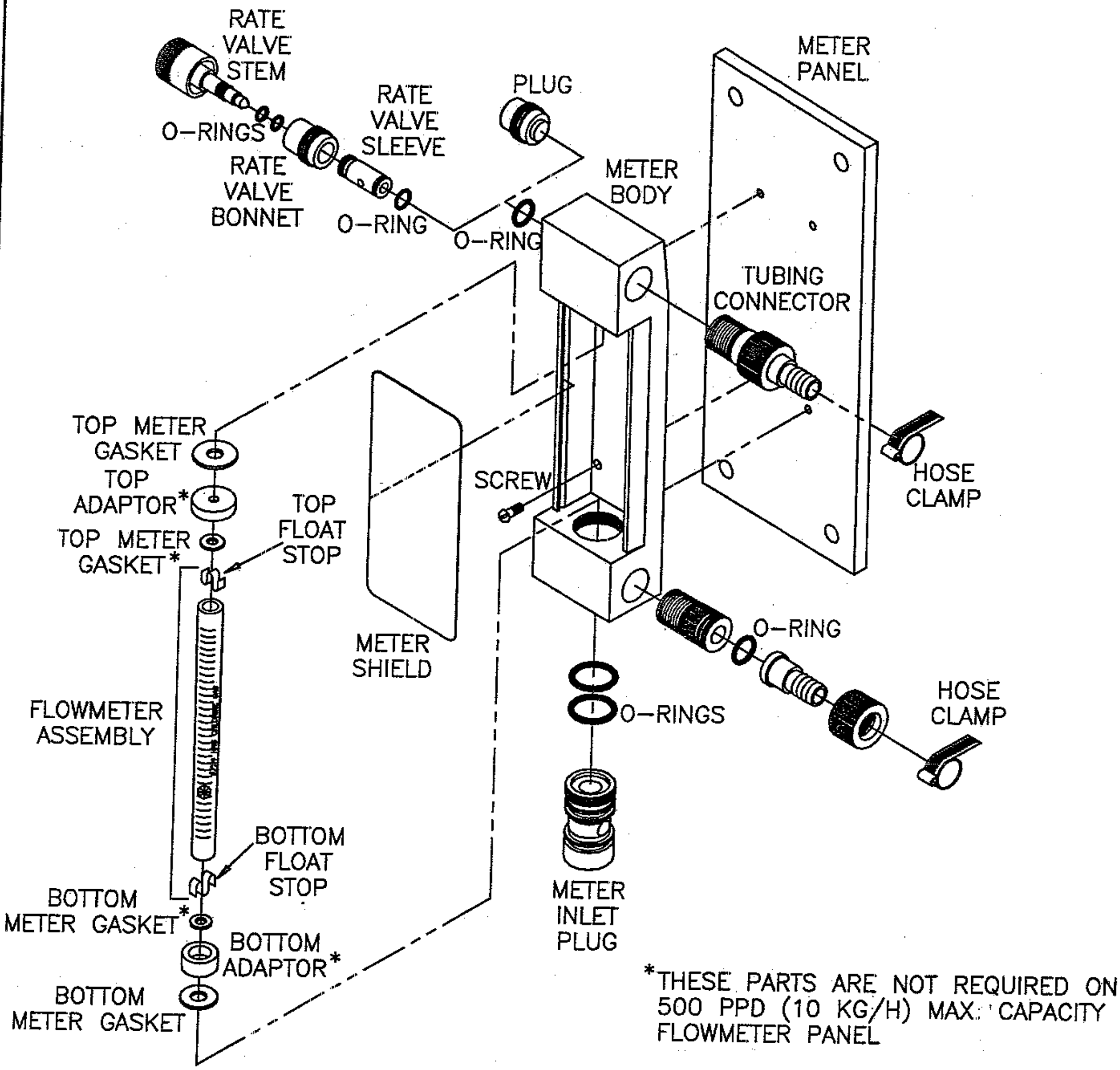


Figure 6 - 300 (6 kg/h) & 500 PPD (10 kg/h) Meter Panel Components

4 SERVICE

Preventative maintenance kits for each of the assemblies are available from the factory. Each kit contains all the parts and detailed instructions that are required for complete maintenance. All o-rings and gaskets that have been disturbed during the disassembly must be replaced during reassembly in order to insure safe, trouble free operation. Failure to replace these parts could result in a shortened operation period and bodily injury.

Refer to Figures 4, 5, and 6

4.1 Cleaning the Flowmeter Assembly

4.1.1 Use a coin or washer as a screwdriver and loosen the bottom meter inlet plug while holding the flowmeter assembly to make sure it does not drop out. It may be necessary to use pliers if the plug has not been removed for some time.

4.1.2 Loosen the plug about three (3) turns and remove the meter assembly. (Push up and out on the flowmeter to remove).

4.1.3 Bend a paper clip or wire and pull out the ball stops on each end of the glass tube. DO NOT LOSE THE METERING BALL.

4.1.4 Clean the inside of the glass tube with a pipe cleaner or bottle brush using wood alcohol, and rinse thoroughly with warm water.

4.1.5 Clean the metering ball using wood alcohol, and rinse thoroughly with warm water

4.1.6 Thoroughly dry the glass metering tube. Reassemble the metering stops and ball.

4.1.7 Reinstall the meter assembly by tightening the meter inlet plug making sure that it is on center with the top and bottom gasket.

NOTE: The meter gaskets can usually be reused. Turn the gaskets over for best results.

4.2 Rate Valve Cleaning

4.2.1 Unscrew the rate valve plug from the valve bonnet.

4.2.2 Remove the valve bonnet from the top of the front body.

4.2.3 Clean the parts by immersing in alcohol or soapy water, rinse, and dry thoroughly with a clean cloth.

4.2.4 The o-rings on the valve bonnet may need replacing if scratched or bruised.

4.2.5 Examine the valve sleeve for nicks or any marks. The sleeve may be removed for this purpose. Use caution to avoid marking the surfaces.

4.2.6 The o-ring on the outside of the valve sleeve usually may not require replacing.

4.2.7 Inspect the rate valve hole in the meter housing and clean with a damp cloth if necessary. DO NOT use any sharp tools that may scratch the internal surface. Never use any solvent for cleaning the plastic, as it will deteriorate rapidly. Wood alcohol can, however, be used successfully.

4.2.8 Apply a thin film of fluorolube grease to o-rings and slide the valve sleeve into the top body.

4.2.9 Replace rate valve.

5 TROUBLESHOOTING CHART

Since the operating performance of the remote meter panel can be effected by the vacuum regulator and ejector, also refer to the Troubleshooting Chart in bulletin 100.6005, 122.6006, 122.6010, or 122.6015.

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
1. The required gas feed rate is not achieved at start-up.	a. Insufficient ejector vacuum due to insufficient water supply pressure for existing back pressure conditions. b. Leakage at vacuum line connections, vacuum regulator and/or inlet to ejector. c. Vacuum line(s) crimped. d. Length of vacuum line(s) exceeds maximum allowable transport distance.	a. Refer to Trouble 2. b. Inspect each connection and remake as necessary. c. Replace vacuum tubing and arrange line(s) to eliminate
2. Flowmeter ball bounces and/or maximum gas feed rate cannot be achieved during normal operation.	a. Vacuum regulator inlet filter screen dirty. b. Rate valve dirty. c. Flowmeter dirty. d. Ejector water supply pressure fluctuating causing insufficient ejector vacuum. (Ball bouncing only)	a. Replace gas inlet filter. b. Clean the rate valve. See Service section. c. Clean the flowmeter. See Service section. d. Check water supply pressure. Correct as necessary
3. Flooded metering tube	a. Dirt on the ejector check valve seat, or worn seat	a. Clean or replace ejector check valve seat. Refer to Ejector instruction manual 122.6006, 122.6010, or 122.6015.
4. Vacuum leaks	a. Rate valve o-rings worn. b. Tubing connector loose. c. Cracks in tubing	a. Replace o-ring. b. Tighten tubing connector c. Replace tubing.

Design improvements may be made without notice.

Represented by:

SEVERN TRENT SERVICES

CAPITAL CONTROLS

Severn Trent Services
3000 Advance Lane Colmar, PA 18915
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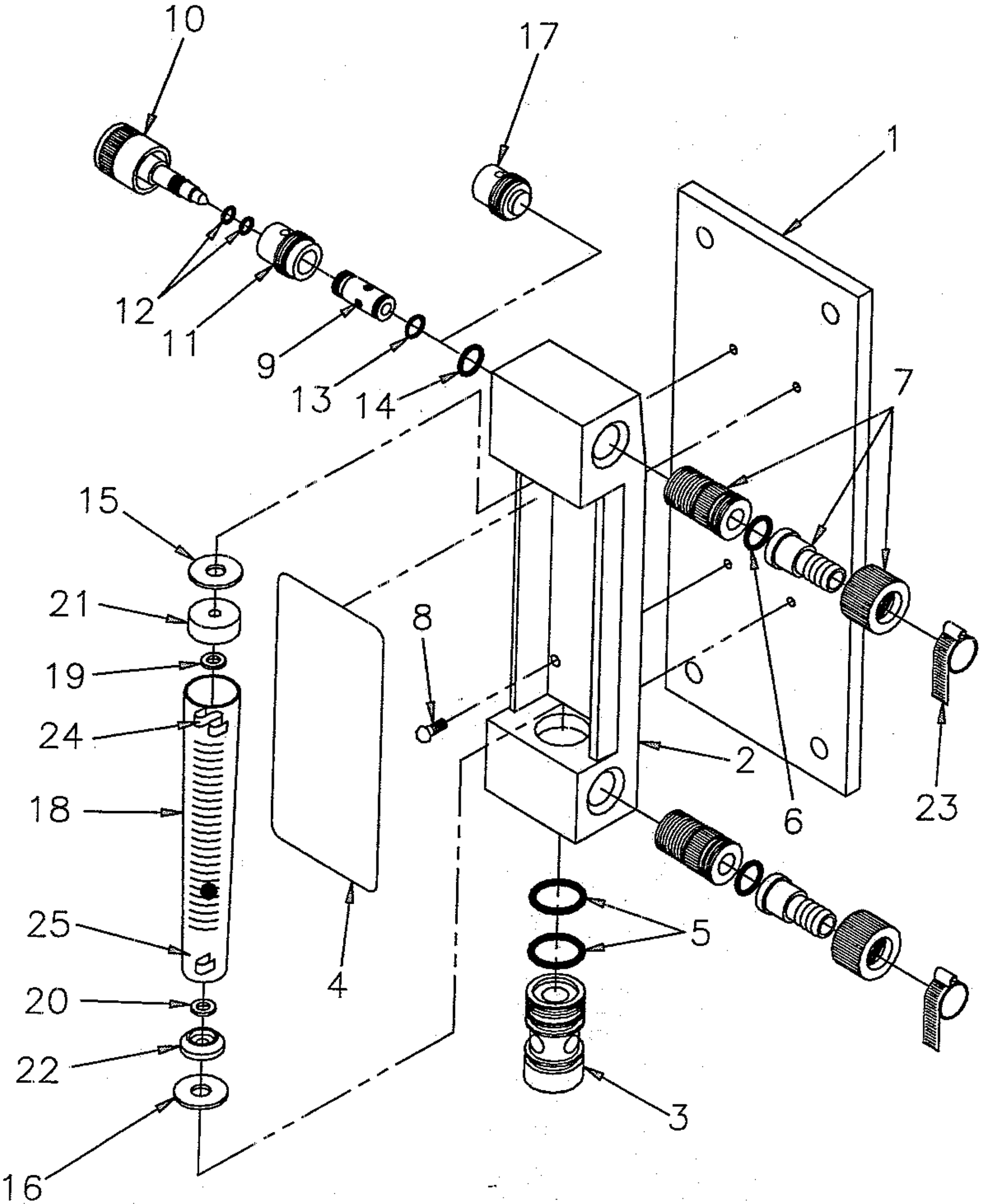
E-mail: marketing@severntrentservices.com

UNITED KINGDOM • UNITED STATES • HONG KONG
ITALY • MALAYSIA

Remote Meter Panel
500 PPD (10 kg/h) Maximum, Chlorine/Sulfur Dioxide
250 PPD (5 kg/h) Maximum, Ammonia

SEVERN TRENT SERVICES

Disinfection Products



See reverse side for parts description

100.7067.7

ITEM	QTY	DESCRIPTION	PART NO. CHLORINE	PART NO. SULFUR DIOXIDE	PART NO. AMMONIA
1	1	METER PANEL	U-259	U-259	U-259
2	1	METER BODY	M-125-1	M-125-1	M-125
3	1	METER INLET PLUG	U-232-1	U-232-1	U-232-1
4	1	METER SHIELD	U-247	U-247	U-247
+ 5	2	O-RING	OV-11-212	OV-11-212	OA-11-212
+ 6	2	O-RING	OV-11-113	OV-11-113	OA-11-113
7	2	TUBING CONNECTOR	F-110-1	F-110-1	F-110-3
8	4	SCREW, 10-24 X 1/2 LG	N-138	N-138	N-138
# 9	1	RATE VALVE SLEEVE	W-116	W-116	W-116-1
# 10	1	RATE VALVE STEM	A-651	A-651	A-652
# 11	1	RATE VALVE BONNET	W-118	W-118	W-118
# + 12	2	O-RING	OV-11-010	OV-11-010	OA-11-010
# + 13	1	O-RING	OV-11-012	OV-11-012	OA-11-012
+ 14	1	O-RING	OV-11-112	OV-11-112	OA-11-112
+ 15	1	TOP METER GASKET	G-116	G-116	G-116-1
+ 16	1	BOTTOM METER GASKET	G-115	G-115	G-115-1
# 17	1	PLUG	U-438	U-438-1	U-438
18	1	FLOW METER ASSEMBLY	SEE CHART I	SEE CHART I	SEE CHART II
+ 19	1	TOP METER GASKET	SEE CHART I	SEE CHART I	SEE CHART II
+ 20	1	BOTTOM METER GASKET	SEE CHART I	SEE CHART I	SEE CHART II
21	1	TOP ADAPTOR	SEE CHART I	SEE CHART I	SEE CHART II
22	1	BOTTOM ADAPTOR	SEE CHART I	SEE CHART I	SEE CHART II
23	2	HOSE CLAMP	R-118	R-118	R-118
24	1	TOP FLOAT STOP BM-1165 & BM-3916 ONLY	U-304	U-304	U-304
25	1	BOTTOM FLOAT STOP BM-1165 & BM-3916 ONLY	U-303	U-303	U-303

CHART I

ITEM		CAPACITY IN PPD (kg/h) 10 (200 g/h)	25 (.5)	50 (1.0)	100 (1.9)	200 (3.9)	300 (6.0)	500 (10)
18	PPD	A-129-1	A-129-2	A-129-3	A-129-5	A-129-6	20057	BM-1165
18	g/h	A-129-1-M						
19		G-119	G-119	G-119	G-100-3	G-100-3	G-100-3	N/R
20		G-119	G-119	G-119	G-118	G-118	G-118	N/R
21	CHLORINE	M-128-1	M-128-1	M-128-1	M-126-1	M-126-1	M-126-1	N/R
21	SULFUR DIOXIDE	M-128-1	M-128-1	M-128-1	M-126-1	M-126-1	M-126-1	N/R
22	CHLORINE	M-129-1	M-129-1	M-129-1	M-127-1	M-127-1	M-127-1	N/R
22	SULFUR DIOXIDE	M-129-1	M-129-1	M-129-1	M-127-1	M-127-1	M-127-1	N/R

CHART II

ITEM		CAPACITY IN PPD (kg/h) 5 (100 g/h)	12.5 (.25)	25 (.5)	50 (1.0)	100 (1.9)	250 (5)
18	PPD	A-1033	A-1034	A-1035	A-1036	A-1037	BM-3916
18	g/h	A-1032					
19		G-119-1	G-119-1	G-119-1	G-100-10	G-100-10	N/R
20		G-119-1	G-119-1	G-119-1	G-118-1	G-118-1	N/R
21		M-128-1	M-128-1	M-128-1	M-126-1	M-126-1	N/R
22		M-129-1	M-129-1	M-129-1	M-127-1	M-127-1	N/R

NOTES:

1. (+) INDICATES PARTS INCLUDED IN KITS FOR MAINTAINING THE REMOTE METER PANEL. ADDITIONAL PARTS AND QUANTITIES SHOULD BE CONSIDERED WHERE THE EQUIPMENT IS USED TO ITS FULLEST CAPABILITY OR WHEN LOCATED IN AN AREA REMOTE FROM CONVENIENT SERVICE.

   TO ORDER A PREVENTIVE MAINTENANCE KIT, PARTS INDICATED BY (+) ORDER:

   CL2 500PPD(10KG/H)------------13223-1
   200PPD(4KG/H)------------13223-2

   SO2 500PPD(10KG/H)------------13224-1
   200PPD(4KG/H)------------13224-2

   NH3 500PPD(10KG/H)------------13225-1
   200PPD(4KG/H)------------13225-2

2. (#) METER PANEL WITH RATE VALVE INCLUDES ITEMS 9, 10, 11, 12, 13 ONLY. FOR METER WITHOUT RATE VALVE, DELETE AND ITEMS 9, 10, 11, 12, AND 13, AND REPLACE WITH ITEM 17.

3. WHEN ORDERING PARTS, SPECIFY GAS FEEDER CAPACITY IN PPD OR g/h, NUMBER OF METERS, WITH OR WITHOUT RATE VALVE, AND SERIAL NUMBER.

USING PARTS OTHER THAN GENUINE STWP PARTS:

- CAN RESULT IN MALFUNCTION OF THE EQUIPMENT AND POTENTIALLY CAUSE SERIOUS PERSONAL AND ENVIRONMENTAL HEALTH AND SAFETY HAZARDS
- WILL VOID YOUR EQUIPMENT WARRANTY
- WILL VOID YOUR LIABILITY CLAIMS TO STS

Severn Trent Services
3000 Advance Lane
Colmar, PA 18915 USA
Tel: 215-997-4000, Fax: 215-997-4062
Service Hotline: 800-523-6526

Warranty Policy for
Severn Trent Water Purification, Inc.
Products & Services

SEVERN TRENT SERVICES

Disinfection Products

1. **Scope of Warranty**
Severn Trent Water Purification, Inc. ("STWP") warrants to the original buyer, products that have been purchased for the purpose identified in our literature. Any warranty granted is void if products are used in any other manner. The Severn Trent Water Purification, Inc. products covered are:
   - Gas dispensers for Cl_2, SO_2, NH_3 and CO_2 service, including related accessories, controls and safety equipment/instrumentation.
   - Analytical Instrumentation & Water Quality Instrumentation.
   - Gas Feed Systems (custom engineered equipment).
   - Parts and Consumable Products for all the above products.
   - UV Disinfection

2. **Standard Warranty**
The standard warranty for Severn Trent Water Purification, Inc. products is detailed in the company's "Terms and Conditions of Sale" (Document # 005.9000), which is the governing document for STWP Warranty Policy. In brief, this states that all warranties cover only material non-conformities or workmanship occurring in the course of manufacturing (not maintenance), and require return to the factory with transportation charges prepaid by the Buyer. More specifically:

   A. **Products - Equipment that is listed in Severn Trent Water Purification, Inc. literature.**
   These products are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning, whichever expires first. (See also Section 3 below.)

   B. **Spare and/or Replacement parts**
   Spare and / or replacement parts are warranted for twelve (12) months from the date of factory invoice

   C. **Consumable Products**
   Products (including chemical reagents) that are depleted during use and/or are date sensitive are considered Consumable Products. Consumable Products are to be stored and used according to STWP literature. Consumable Products are warranted against defects in material, formulation and workmanship occurring in the course of manufacturing up to the expiration and/or "use by" date. Instrument probes are warranted for a period of ninety (90) days from the date of factory invoice. To substantiate a failure in warranty, claimant must provide detailed information to the STWP factory. Any warranty granted by STWP is void if Consumable Products are used on products other than Severn Trent Water Purification, Inc. Also, if other than Severn Trent Water Purification, Inc. products are used on Severn Trent Water Purification, Inc. instruments, this may void the warranty.

   D. **Equipment Manufactured by Others**
   Products purchased from another manufacturer and supplied by STWP for the convenience of the customer, or as part of a system, carry the warranty of the original manufacturer. The customer should contact the original manufacturer directly about warranty issues; or STWP, upon request, will act as an agent when dealing with warranty issues. If STWP acts as an agent the customer must return equipment to the designated factory, shipping charges pre-paid. Customers' sole remedy is the original equipment manufacturer's warranty.

   E. **Systems - Custom Engineered Equipment**
   STWP warrants all products that are integrated and arranged into a system (which conform to the functional intent of the customers specifications and has been approved by the customer) for performance to Severn Trent Water Purification, Inc. documented specifications. This warranty is for material defects in components and workmanship occurring in the course of our manufacturing.

   All material defects in components and workmanship occurring in the course of commissioning and start-up not performed by STWP are not covered under this warranty. These systems are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning (requires written notice of customer's acceptance of product), which ever expires first. The claimant must provide written notice (including details of functional operation during failure) of any defect(s) to substantiate the failure in warranty to the STWP factory.

F. Field Service

STWP warrants all start-up work performed by our Field Service personnel for the same duration as our product and/or system warranty for material defects in components and workmanship occurring in the course of our work, but not the product or system application.

Customer is responsible for operating, maintaining (including changing consumables), and calibrating the product and/or system as described in the manual(s) provided by STWP.

All maintenance and/or repair performed by Severn Trent Water Purification, Inc. Field Service is warranted for a period of one-hundred and twenty (120) days from the date of service, or until the end of the original warranty period if service is performed during the warranty period, whichever is longer.

G. **Factory Repair**

STWP warrants that all factory repairs made to a product, under customer purchase order or warranty, will operate within documented technical specifications for a period of one-hundred and twenty (120) days from date of shipment, or until the end of the product's original warranty period, whichever is longer.

3. **Extended Product Warranty**

A. **Series 200, Model 480 and Series NXT3000**

The Vacuum Regulator ("VR") and Meter Assemblies within individual 200, 480 and NXT3000 chlorinators, ammoniators, carbonators or sulfonators with the original serial number intact are warranted for thirty-six (36) months from the date of factory invoice against defects in material and workmanship occurring in the course of manufacturing. (This extended warranty does not apply to Ejector assemblies.) The following parts incorporated in the Series 200, Model 480 and Series NXT3000 Vacuum Regulator assembly carry a Lifetime Warranty against any defects in material and workmanship:

Series 200 & Model 480 Series NXT3000-

Springs-Hastelloy C Inlet Body and Spring-Halar Diaphragm-Halar Diaphragm

4. **Important Notes**

STWP may require the return of defective/non-conforming products to its factory for examination and testing to verify non-conformity. A confirmed non-conformity, within the applicable warranty period, will be repaired or replaced as determined by STWP. Warranty does not include any installation, removal or freight expenses that might be associated with warranty repair or replacement.

In situations where STWP agrees that it is not feasible for the claimant to return equipment to the factory, a purchase order will be required to dispatch a Service Technician and the claimant will only be invoiced if the product is found to be not warrantable.

STWP will make no allowance or reimbursement for repairs, alterations, replacements, or work of any kind done or ordered by others without prior written authorization by STWP.

The original buyer's sole remedy for breach of warranty for a product and/or service shall be at STWP's sole option to either repair or replace non-conforming product and/or service. If required, after evaluation and determination that a product is non-conforming by reason of manufacturing, STWP can refund the original buyer's purchase price for such product or service. Design improvements may be made without notice.

Design improvements may be made without notice.

Represented by:

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Decontamination Certificate

SEVERN TRENT SERVICES

Disinfection Products

THE FOLLOWING CLEANING PROCEDURES (SEE PAGE 2) MUST BE IMPLEMENTED AT THE CUSTOMER'S EXPENSE IF THE EQUIPMENT IS TO BE RETURNED TO THE FACTORY FOR SERVICE.

This sheet must be attached to the outside of each (if more than one) shipping carton, along with any applicable MSDS health/material handling recommendations.

FAILURE TO PROPERLY CLEAN THE EQUIPMENT OR ATTACH THE DECONTAMINATION CERTIFICATE TO THE OUTSIDE OF THE CARTON WILL RESULT IN THE EQUIPMENT BEING RETURNED UNREPAIRED.

Decontamination Statement

RA Number (WARRANTY & CREDIT RETURNS ONLY): ____________________

Equipment to be returned: ____________________

Model #: ____________ Serial #: ____________ PO#: __________ Date of PO: __________

Application: ☐ Waste Water ☐ Potable Water ☐ Industrial Process (MSDS Required)

List all chemical and process fluids in contact with the equipment.
Attach additional pages if necessary.

____

____

____

____

____

I hereby certify that the equipment being returned has been prepared for shipment and decontaminated in accordance with the procedure stated on page 2 of this document corresponding to the product that is being returned. The equipment is in compliance with OSHA and DOT regulations. This equipment poses no health or safety risks due to contamination.

By: ____________________ (Signature) ____________________ (Please Print)

Title: ____________________ Date: ____________________

Company Name: ____________________

Phone Number: ____________________ Fax Number: ____________________

Detailed Reason for Return: ____________________

____

____

CHLOR-A-VAC
- Flush out the vacuum connection of any residue chemicals.
- Remove all treatment facility process solids adhering to the CHLOR-A-VAC unit (including the inside of the vacuum housing) and the power cord with a pressure washer
- Scrub the CHLOR-A-VAC and the power cord using a 10% solution of household bleach. Rinse thoroughly with potable water.
- Pack with appropriate restraints and packing materials to prevent shipping damage.

Liquid Feed
- Liquid Dosing Systems - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.
- Chlorine Dioxide Generators (All-Liquid Systems only) - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets - For chlorine gas type generators, consult factory.
- Tablet Feeders - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.

Gas Feed
- Pull air through system for 15 minutes with rate valve fully open. Wipe down exterior surfaces.

Instrumentation
- Wipe down exterior surfaces.

Analyzers
- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Aztec Monitors
- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Utraviolet Equipment
- Remove all treatment facility process solids to the unit with a pressure washer. Wipe down exterior surfaces. Package lamps and quartz separately.

pH probes
- Rinse with potable water

Dissolved Oxygen Probes
- Rinse probe and container with potable water. Wipe down exterior surfaces. Pack probe in container with potable water.

EST Equipment - (Included but not limited to Eductors, Steam Jets/Vacuum Systems, Scrubbers and Desuperheaters.) Due to the vast range of individually specific applications, an all encompassing decontamination procedure cannot apply. For this reason the end user bears responsibility for specific decontamination procedures. As a minimum the following shall apply:

- Remove and neutralize all acids and bases or other corrosive contaminants.
- Thoroughly purge equipment of all poisonous or noxious chemicals and irritants.
- Remove all foreign material, precipitate, fouling, scale, residue and/or noxious odor.

After the above has been completed, the equipment should be thoroughly rinsed using clean water and a mild detergent and be completely dried prior to packaging for return

Design improvements may be made without notice

Represented by:

SEVERN TRENT SERVICES

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Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

SEVERN TRENT SERVICES

Disinfection Products

Subject: Gas Feed Product Spare Parts

Dear Valued Customer,

As a user of Severn Trent Water Purification, Inc. products, you are a significant reason for the continued success of this company. All of us at STWP want to thank you for your business.

We appreciate this opportunity to present our views on "interchangeable" spare parts. Many of our smaller competitors, in an effort to gain market share, have developed "knock-off" spare parts for many of the products that we manufacture for gas feed applications. Since patent protection has expired, we have seen a significant attempt to flood the market with these "knock-off" parts.

Obviously, STWP wants to protect its' spare parts business but we feel that there are significant issues that you should consider.

We believe municipal procurement practices which call for sourcing from the lowest priced supplier serve the public well. But lower priced "knock-off" parts can seriously endanger the welfare of the public as well as your operators.

We are committed to providing the highest quality parts at competitive prices As a manufacturer of gas feed equipment with over 45 years of experience, we have an enviable safety record. This record has been earned through meticulous attention to design, materials and quality. You may not know that we pioneered the all-vacuum method of gas feed and that we have been certified to the worldwide ISO 9001 quality standard since 1991.

Using parts other than genuine STWP parts:

- ***can result in malfunction of the equipment and potentially cause serious personal and environmental health and safety hazards***
- ***will void your equipment warranty***
- ***will void your liability claims to STWP***

We are extremely concerned about these issues and believe you are as well. Our recommendation is that your procurement policy for gas feed parts and equipment require that:

- ***replacement/spare parts always be sourced from the original manufacturer, and***
- ***you have evidence of substantial product liability insurance***

These measures preserve product integrity and safety, and your right of recourse in the event of an occurrence.

With the current public and various safety agency concerns, we strongly believe that these are critical issues for our industry, our customers and their employees

Should you have any questions or comments, I would very much like to hear from you. You can email me at jblundi@severntrentservices.com or call me at 215 997 4065.

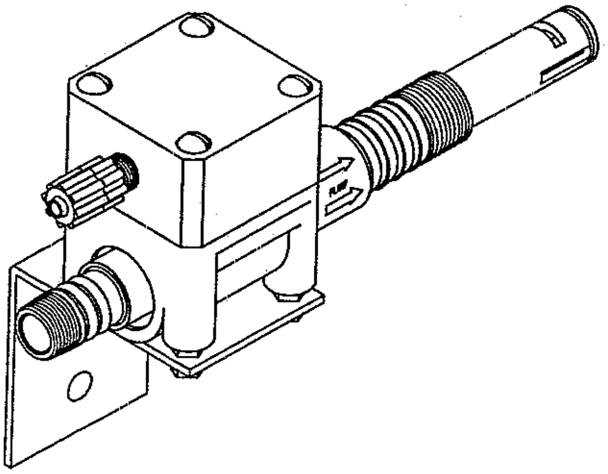
James R. Blundi
Director
Gas Feed and Instrumentation

EJ 500C

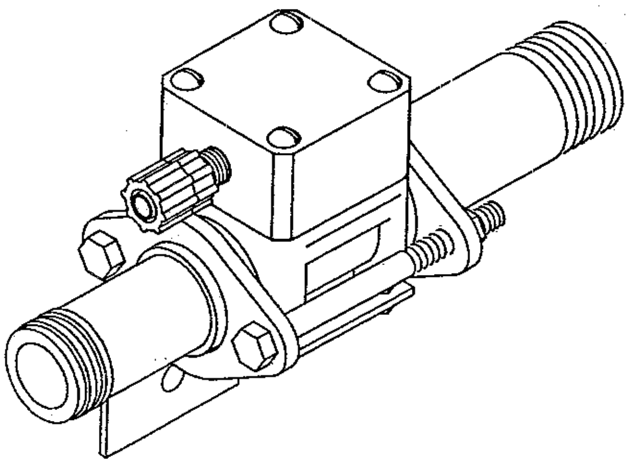
Instruction Manual — O-Ring Ejector Chlorine & Sulfur Dioxide to 500 PPD (10 kg/h)

SEVERN TRENT SERVICES

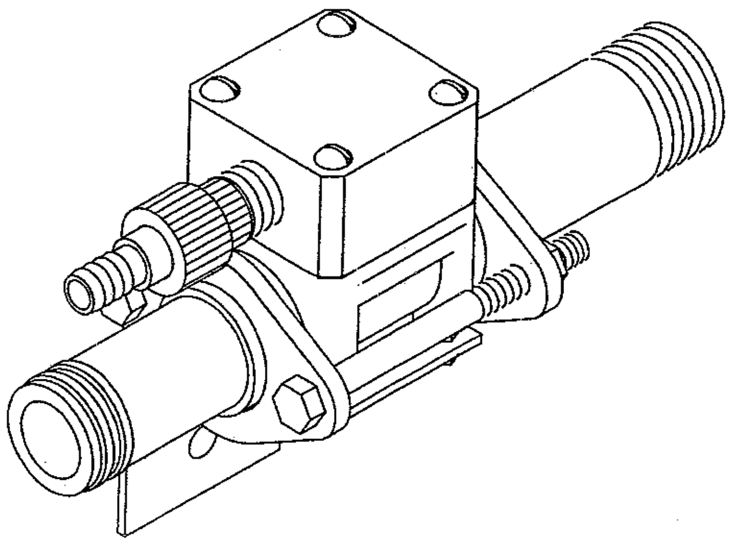
CAPITAL CONTROLS



100 PPD (2 kg/h) Maximum



250 PPD (5 kg/h) Maximum



500 PPD (10 kg/h) Maximum

These instructions describe the installation, operation and maintenance of the subject equipment. Failure to strictly follow these instructions can lead to an equipment rupture that may cause significant property damage, severe personal injury and even death. If you do not understand these instructions, please call Severn Trent Water Purification for clarification before commencing any work at 215-997-4000 and ask for a Field Service Manager. Severn Trent Water Purification, Inc. reserves the rights to make engineering refinements that may not be described herein. It is the responsibility of the installer to contact Severn Trent Water Purification, Inc. for information that cannot be answered specifically by these instructions.

Any customer request to alter or reduce the design safeguards incorporated into Severn Trent Water Purification equipment is conditioned on the customer absolving Severn Trent Water Purification from any consequences of such a decision.

Severn Trent Water Purification has developed the recommended installation, operating and maintenance procedures with careful attention to safety. In addition to instruction/operating manuals, all instructions given on labels or attached tags should be followed. Regardless of these efforts, it is not possible to eliminate all hazards from the equipment or foresee every possible hazard that may occur. It is the responsibility of the installer to ensure that the recommended installation instructions are followed. It is the responsibility of the user to ensure that the recommended operating and maintenance instructions are followed. Severn Trent Water Purification, Inc. cannot be responsible deviations from the recommended instructions that may result in a hazardous or unsafe condition.

Severn Trent Water Purification, Inc. cannot be responsible for the overall system design of which our equipment may be an integral part of or any unauthorized modifications to the equipment made by any party other that Severn Trent Water Purification, Inc.

Severn Trent Water Purification, Inc. takes all reasonable precautions in packaging the equipment to prevent shipping damage. Carefully inspect each item and report damages immediately to the shipping agent involved for equipment shipped "F.O.B. Colmar" or to Severn Trent Water Purification for equipment shipped "F.O.B Jobsite" Do not install damaged equipment.

SEVERN TRENT SERVICES, COLMAR OPERATIONS
COLMAR, PENNSYLVANIA, USA
IS ISO 9001: 2000 CERTIFIED

TABLE OF CONTENTS

1 INTRODUCTION

1.1 General

The ADVANCE® ejectors are expertly engineered and carefully tested to assure yearsof satisfactory operation. They are constructed of the finest materials available for gas service. Correct installation and proper care will ensure best operation. Read instructions carefully and save for future reference.

This instruction manual only covers our standard O-Ring ejector (Reference 122.3001). If another ejector is used, reference one of the following:

Diaframless -122.4001, 122.3011.
Anti-siphon -122.3013 , 122.3012.
Variable Orifice - 122.3010 and 122.6050.

NOTE: The Series 200 O-Ring ejectors are designed for use with Series 200 gas feeders.

1.2 Warranty

See Bulletin 005.9001 for the ADVANCE® equipment warranty.

1.3 Specifications

1.3.1 Gas Flow

Capacity	Vacuum Tubing Size	Inlet Nozzle	Outlet Diffuser
100 PPD (2 kg/h)	3/8" 1/2" 5/8"	1" hose/universal 3/4" thread	Universal - 3/4" NPT male thread, spray or open-end, or 1" hose, 3/4" hose
250 PPD (5 kg/h)	1/2" 5/8"	1 1/4" thread 1 1/2" hose	1 1/4" thread 1 1/2" hose
500 PPD (10 kg/h)	5/8"	1 1/4" thread 1 1/2" hose	1 1/4" thread 1 1/2" hose

Different inlet nozzle and diffuser combinations are available for the ejectors. Your particular combination was chosen for your application.

a. A universal diffuser can be used four different ways; spray diffuser, open-end diffuser, 3/4" threaded connection, or 1" hose connection. Choose the type suited for the installation (spray is recommended for good mixing). If other than spray is desired, modify by cutting off the closed end.
b. The ejector (nozzle and check valve assembly) may be located near the vacuum regulator. A wall mounting bracket is available for field assembly, and the universal diffuser can be modified for a pipe or hose connection.
c. The entire diffuser-ejector assembly may be submersed in an open channel or tank.
d. Diffuser tubes with corporation stops can be supplied for either close-coupled or remote ejectors.
e. Corporation stops are recommended for high pressure pipeline applications and perforated pipe diffusers are recommended for good mixing in open tanks or channels.

1.3.2 Back Pressure

Maximum back pressure at the point of application is 19 psig (1.3 bar). High pressure systems 20 to 140 psig (1.4 to 10 bar) can be accommodated with a high pressure ejector. Consult factory if higher than 140 psig (10 bar) back pressures are required.

2 OPERATION

2.1 General

The ejector is designed to complement Severn Trent Services Series 200 vacuum regulators. The ejector is the heart of the system providing the vacuum necessary to operate the vacuum regulator. The diaphragm ejector is to be used in continuous feed applications.

2.2 Installation - Figure 1

The ejector may be installed in any position, since the check valve is spring actuated. (However, downward water flow may cause cavitation and poor vacuum).

The point of injection should be carefully chosen so the water pressure into which the gas is fed, is as low as possible. If the ejector is installed in a pipe, the ejector-diffuser should not be installed in the top of the pipe where gas may discharge and collect in an empty area of the pipe. Diffuser penetration into the pipe should not exceed 1/3 of the diameter of the pipe.

Proceed as follows to install pipe mounted close-coupled diffuser and ejector.

2.2.1 Unscrew the diffuser from the assembly. Do NOT install the ejector with the diffuser attached, or damage may occur.

2.2.2 Put Teflon tape on the diffuser pipe threads and screw the diffuser into the pipe by hand. Tighten carefully with pliers. (Make sure that the holes in the spray tube diffuser are in the main stream.) The end of an open- end type diffuser should not allow strong chemical solution to come in contact with pipe or fittings. (This will cause serious corrosion.

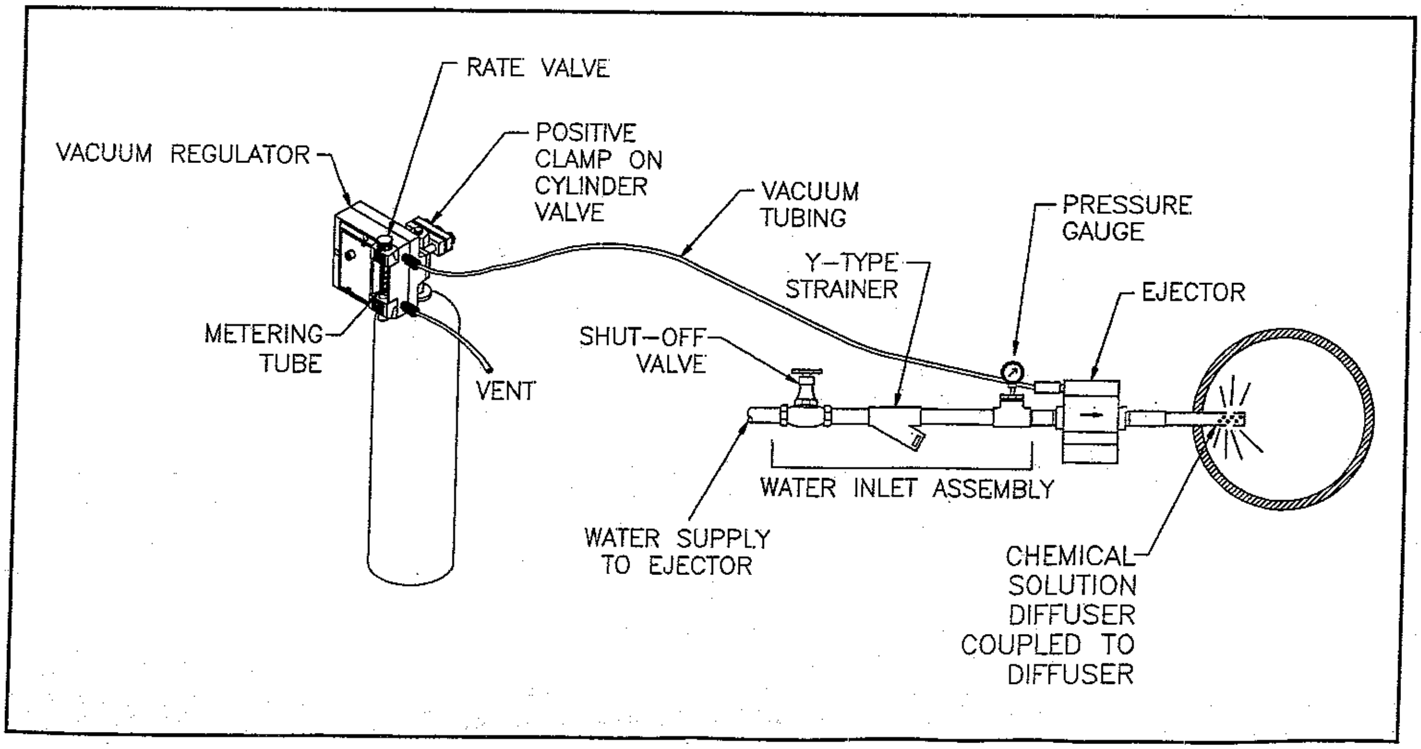


Figure 1 - Gas Feed System Flow Diagram

2.2.3 Reconnect nozzle and check valve assembly to diffuser. The nozzle may extend through the assembly from either side. A gasket should be on each side. Screw the nozzle into the diffuser **HAND TIGHT.** (The check valve assembly may be installed in any position.)

2.2.4 Other types of diffuser and ejector installations may be desired for certain applications:

a. The ejector (nozzle and check valve assembly) may be located near the vacuum regulator. A wall mounting bracket is available for field assembly, and the universal diffuser can be modified for a pipe or hose connection.

b. The entire diffuser-ejector assembly may be submersed in an open channel or tank.

c. Diffuser tubes with corporation stops can be supplied for either close-coupled or remote ejectors.

2.3 Ejector Vacuum

The ejector creates a vacuum only when sufficient pressure differential exists between the ejector inlet water versus the water outlet pressure.

For example, if the diffuser were discharging into an empty basin (zero back pressure), the supply pressure to the nozzle requires about 25 psig (2 bar) to create enough vacuum to operate a 50 PPD (1 kg/h) vacuum regulator. A lower supply pressure or a higher back pressure would reduce the gas flow rate.

Then for each 1 psig (0.07 bar) of back pressure above zero, the supply pressure must be increased about 2 to 3 psig (0.1 to 0.2 bar) above 25 psig (2 bar). A back pressure of 10 psig (0.7 bar) would therefore require about 55 psig (4 bar) supply pressure in order to operate the 50 PPD (1 kg/h) vacuum regulator. Also, the water supply line to the nozzle must be large enough to allow sufficient water flow (3/4" or larger pipe is recommended) and minimize friction losses.

2.4 Piping

For most installations, the ejector water supply line should be brought to within 4-6 ft. (1-2 m) of the nozzle with rigid copper or iron pipe. A shutoff valve followed by a Y-strainer, and a hose adapter or pipe union should be installed to allow removal for service. A pressure gauge between the Y-strainer and the ejector can be a useful service tool.

If the hose is used, connect the hose between the hose adapter or pipe union and the ejector nozzle. Clamp the hose securely at both ends with single or double clamps.

2.5 Vacuum Connections - See Figure 1 and Introduction, Gas Flow section Table A.
Black polyethylene tubing is normally used for the vacuum line between the vacuum regulator and ejector. Use enough length for each line to allow vacuum regulator movement from one cylinder to another.

2.5.1 Remove the connector nut from the vacuum regulator connection and slip onto the tubing. Push the tubing onto the connector and tighten connector nut **HAND TIGHT**.

2.5.2 The upper connection on the vacuum regulator is for vacuum tubing to ejector.

For example, if the diffuser were discharging into an empty basin (zero back pressure), the supply pressure to the nozzle requires about 25 psig (2 bar) to create enough vacuum to operate a 50 PPD (1 kg/h) vacuum regulator. A lower supply pressure or a higher back pressure would reduce the gas flow rate.

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3 START-UP

3.1 Vacuum Check

The ejector, its water supply and solution lines, must be properly installed and checked before operating the vacuum regulator. Unless the ejector is creating a vacuum, the vacuum regulator will not work.

3.1.1 Disconnect the vacuum tubing from the ejector.

3.1.2 Open the ejector water supply valve. The ejector should now be in operation and creating a vacuum.

3.1.3 Put your finger on the vacuum connector opening and feel the vacuum. There should be no doubt that a vacuum exists. If there is no vacuum, be certain the supply pressure is sufficient and the nozzle or piping is not plugged. Correct the condition and obtain proper vacuum before proceeding with vacuum regulator operation. (Reference vacuum regulator instruction manual)

3.1.4 Reconnect the vacuum tubing to the ejector. Leave the ejector running.

4 SERVICE

It is recommended that the Gas Dispensing System be inspected and serviced a minimum of once per year.

More frequent service periods may be required due to: 1) the type, quality and quantity of the gas being handled, 2) the complexity of the gas supply system, 3) the quality and quantity of water or process liquid being used to operate the ejector(s), and 4) operation procedures.

More frequent service periods are especially indicated when venting of the VR is occurring during the one year operational period. This is usually indicative of foreign debris holding the inlet valve open or destruction of the inlet valve parts caused by the gas quality not up to industry purity standards.

Preventative maintenance kits for each of the assemblies are available from the factory. Each kit contains all the parts and detailed instructions that are required for complete maintenance. All o-rings and gaskets that have been disturbed during the disassembly must be replaced during reassembly in order to insure safe, trouble free operation. Failure to replace these parts could result in a shortened operation period and bodily injury.

4.1 Nozzle Cleaning

Shut off the water supply valve or bypass the ejector. Remove the ejector. Refer to Figures 1, 2 or 3 and remove the nozzle as follows:

4.1.1 Remove the connecting hose to the ejector assembly.

4.1.2 For 100 PPD (2 kg/h) ejectors, rotate the complete ejector body counterclockwise. This loosens the threaded portion of the nozzle from the diffuser, eliminating the need for pliers on the hose connection which may damage the plastic.

For 250 & 500 PPD (5 & 10 kg/h) ejectors, remove the two (2) screws and loosen the flange to remove the nozzle.

NOTE: Nozzle plugging can be caused by foreign material (pipe scale, stone, dirt accumulation). This can usually be blown out or pushed out with a wire.

* Build-up of deposits caused by iron, manganese or other material can usually be remove by immersing the nozzle in muriatic acid and rinsing. Some waters may cause an inoperable ejector and require nozzle cleaning every two months.

4.1.3 To reinstall the nozzle, insert the nozzle through the ejector body and fasten to the diffuser using new gaskets, or o-rings on each side of the ejector body.

NOTE: These parts are plastic and excessive tightening may cause breakage. For 100 PPD (2 kg/h) ejectors, tighten only hand tight with the ejector body 90° to the left of its final position, then turn the complete assembly 90°.

4.1.4 Reinstall the ejector supply hose or pipe and vacuum tubing.

4.2 O-Ring Replacement

Ejectors contain an o-ring that should be checked and the o-ring/diaphragm bolt assembly replaced as necessary.

4.3 Diaphragm Replacement - Refer to Figures 2, 3 or 4

4.3.1 Remove the four bolts holding the ejector together to expose the internal parts.

4.3.2 The diaphragm bolt assembly is tightened at the factory, but can usually be separated by using large, jaw pliers or a vice. All assemblies contain a support diaphragm. In high pressure applications, the assembly includes two thin plastic support diaphragms.

4.3.3 Replace the diaphragm and reassemble the diaphragm nut and bolt. These must be assembled tightly using jaw pliers or a special tool to tighten. Install the diaphragm assembly in the recess of the top hole, and bolt the two sections together. (Note diaphragm orientation on Figure 2, 3 or 4).

4.3.4 No adjustments are necessary, but ensure both ends of the spring are square.

4.4 Functional Test

When the ejector is reassembled, a functional test of the check valve assembly is recommended to check for proper ejector assembly and prevent future flooding of the vacuum regulator

4.4.1 Do not connect vacuum tubing to vacuum regulator.
4.4.2 Turn on water supply.
4.4.3 Verify vacuum at ejector.
4.4.4 Turn water supply off for approximately 5 minutes. If ejector is assembled properly, no water will leak from vacuum tubing.

4.5 Recommended Torque Values

Torque values of 14 inch pounds for ejector body screws on units up to 500 PPD/10 kg/h are used at the factory, and are recommended guidelines for Reassembly of a repaired unit.

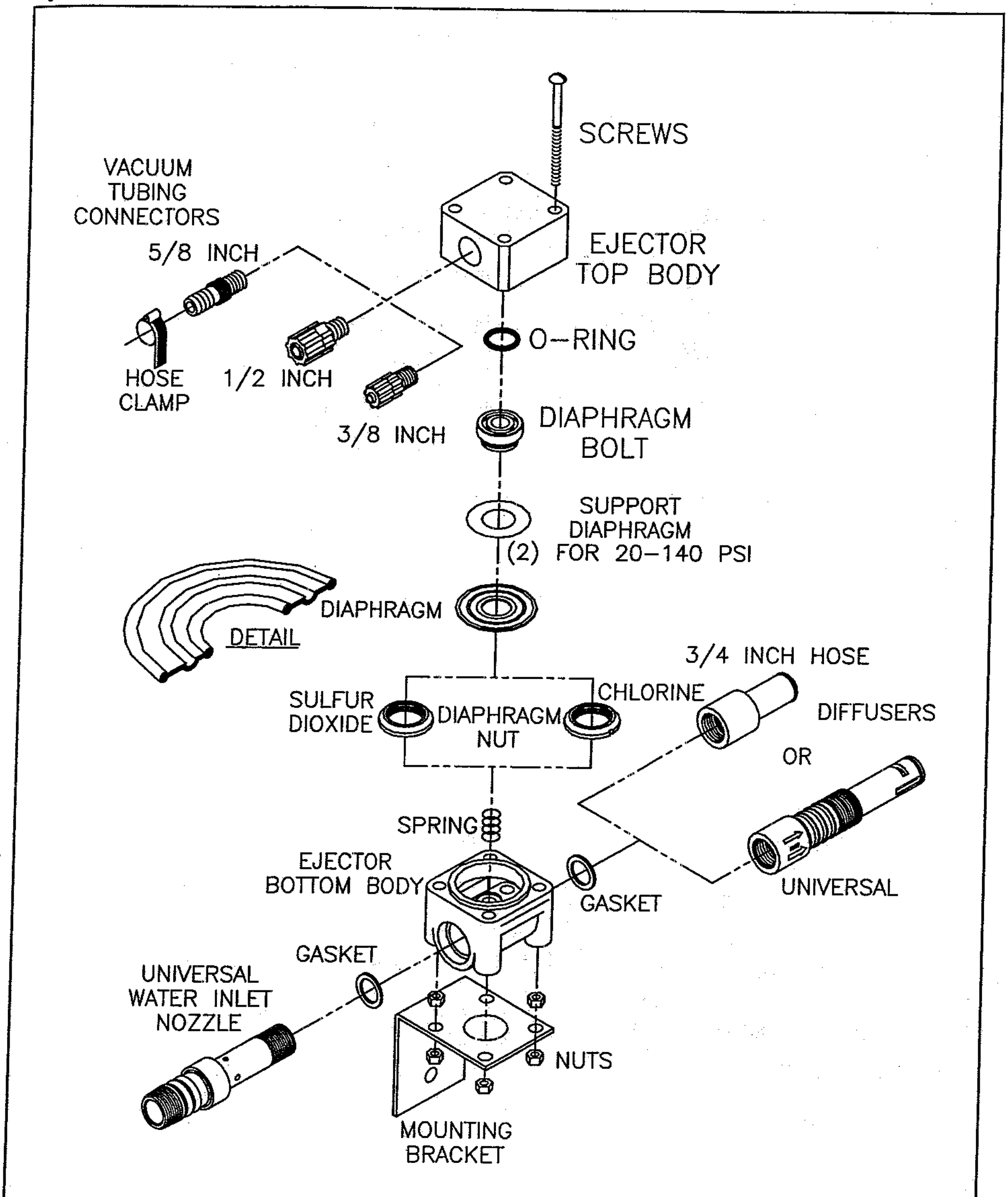

Figure 2 - 100 PPD (2 kg/h) Ejector

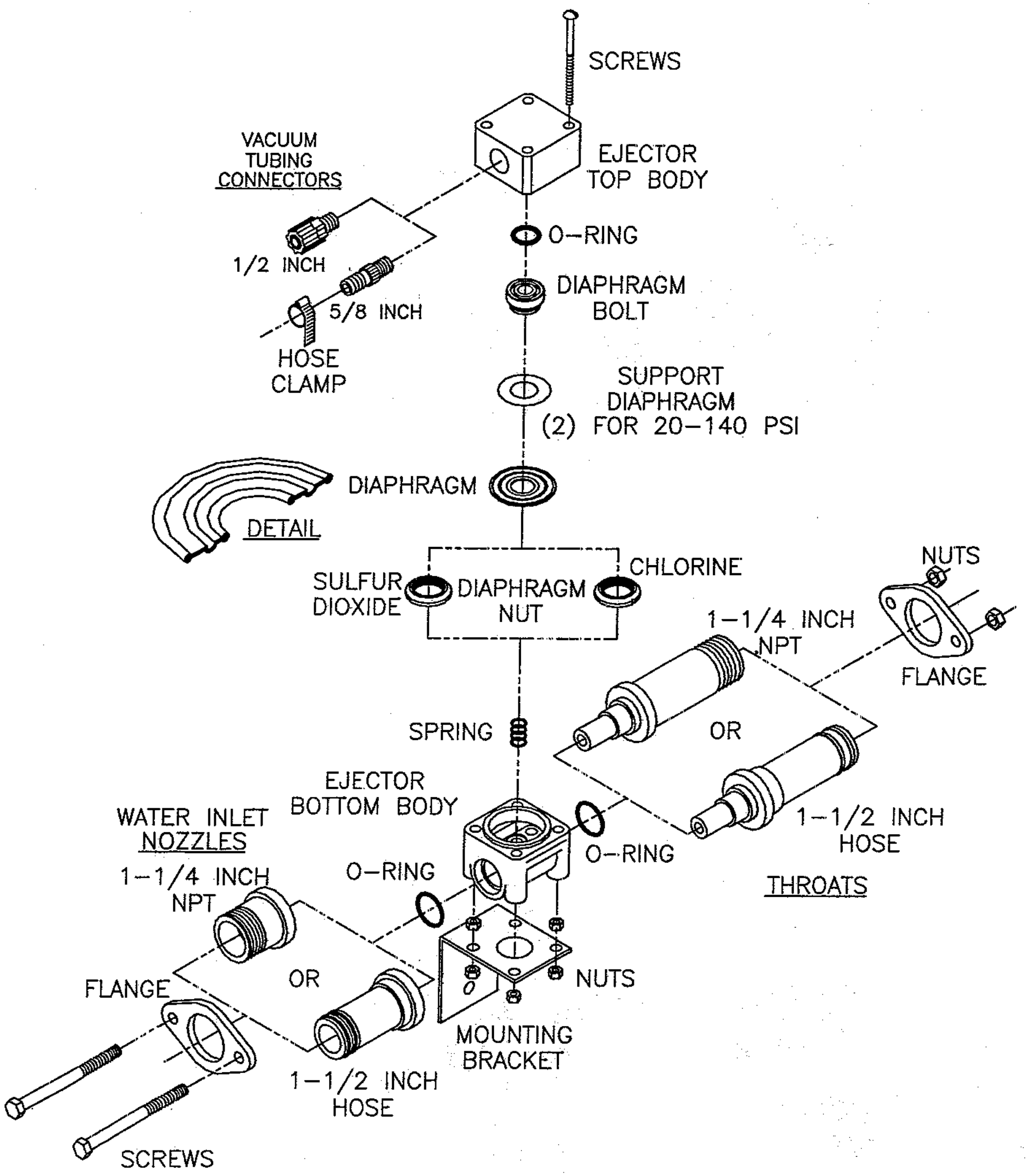

Figure 3 - 250 PPD (5 kg/h) Ejector

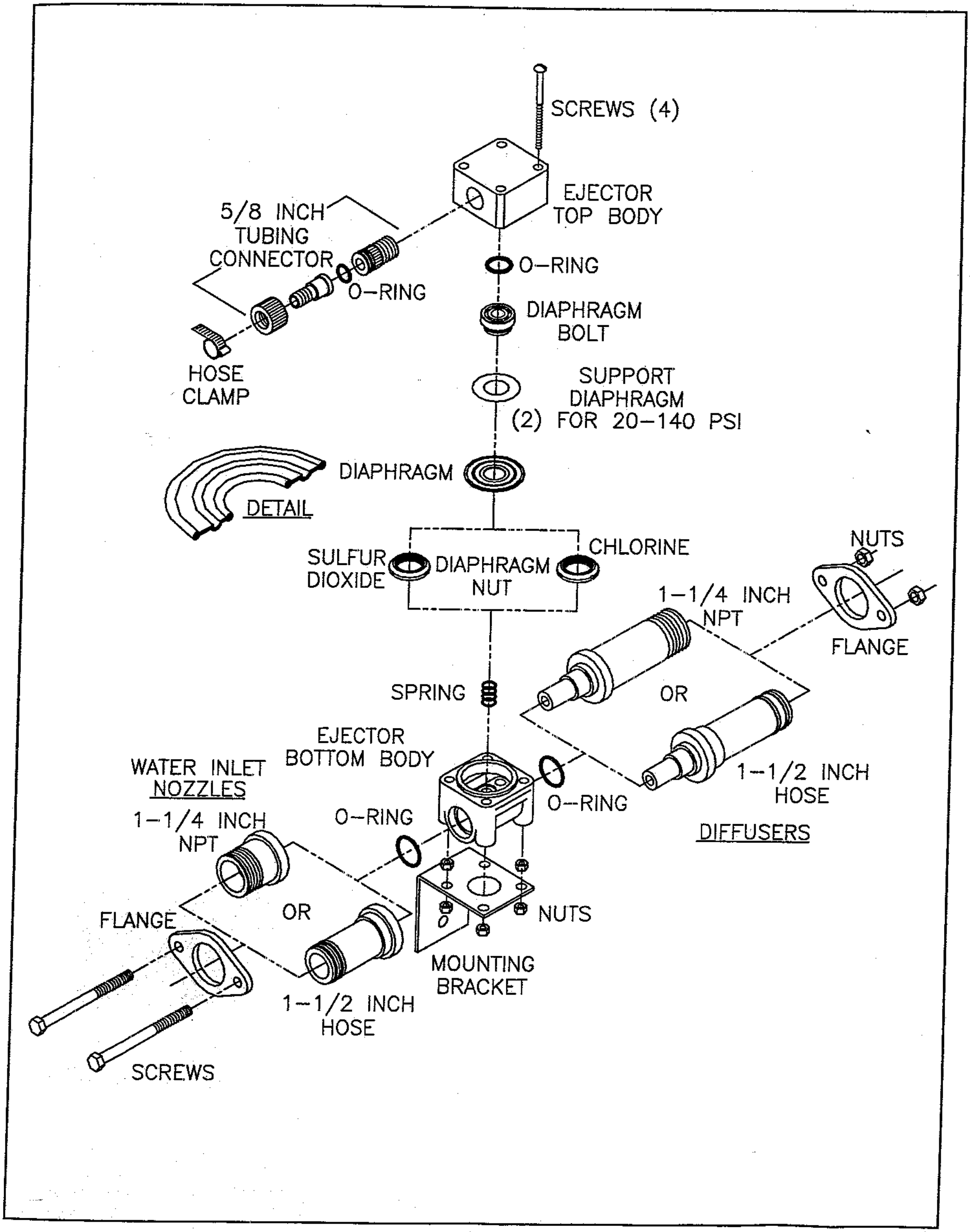

Figure 4 - 500 PPD (10 kg/h) Ejector

T-Y-strainer

5 TROUBLE SHOOTING CHART

Trouble	Probable Cause	Corrective Action
1. Insufficient ejector vacuum.	a. Y-strainer in water supply dirty. b. Supply pressure too low. c. Back pressure too high. 1. Solution valve, if supplied, not fully open. 2. Solution line, if present, partially blocked. d. Velocity too low (cavitation.) e. Nozzle 1. Flow restricted 2. worn or damaged. f. Incorrect nozzle size. g. Improper installation.	a. Clean Y-strainer b and c. Open solution valve; clean solution line; correct back pressure condition. d. Increase pressure to ejector. e-g. Clean nozzle and/or throat. See Service section and bulletin 123 3001
2. Flooded flowmeter	a. Dirt on the ejector o-ring. b. Worn or damaged diaphragm c Improper application	a. Clean or replace ejector o-ring. See Service section. b. Replace worn diaphragm. See Service section. c. See bulletin 123.3001 on hydraulic considerations.
3. O-Ring sealing surface of ejector top body is extruding into diaphram bolt.	a. Rare chemical anomaly.	a. Replace ejector top body with P/N U-2372-4.

Design improvements may be made without notice.

Represented by:

SEVERN TRENT SERVICES

CAPITAL CONTROLS

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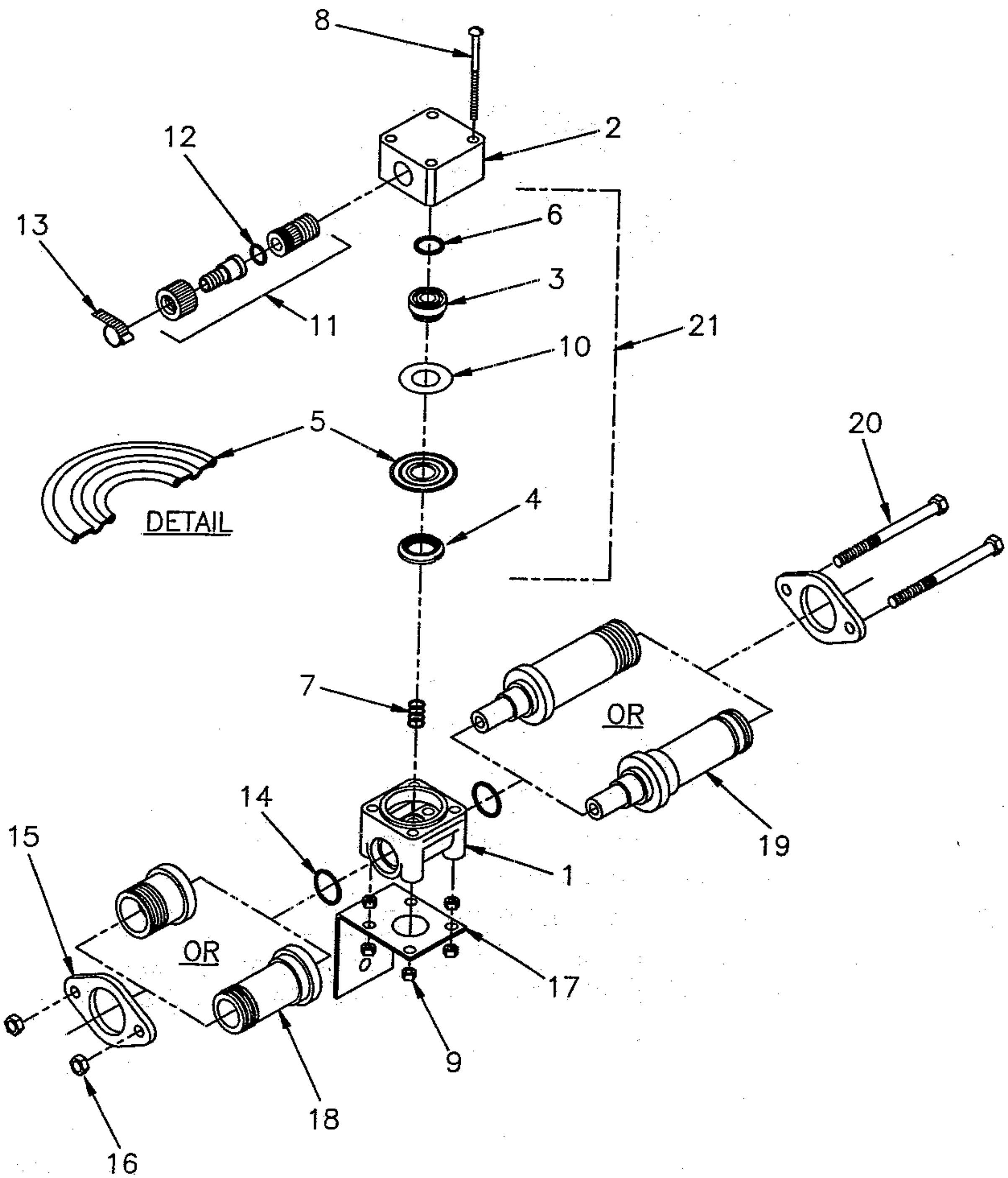
3000 Advance Lane Colmar, PA 18915
Tel: 215-997-4000 • Fax: 215-997-4062
Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

Ejector - O-Ring
500 PPD (10 kg/h) Maximum
Chlorine/Sulfur Dioxide

SEVERN TRENT SERVICES

CAPITAL CONTROLS



See reverse side for parts description

ITEM	QTY	DESCRIPTION	PART NO.
1	1	BOTTOM BODY	E-153
2	1	TOP BODY	U-237-1
3	1	DIAPHRAGM BOLT	SEE CHART I
4	1	DIAPHRAGM NUT	SEE CHART I
5	1	DIAPHRAGM	D-104
6	1	O-RING	OC-11-210
7	1	SPRING	S-106
8	4	SCREW, 5/16-18 X 4 LG	N-136
9	8	NUT, 5/16-18	N-104
10	1	SUPPORT DIAPHRAGM	SEE CHART III
11	1	TUBING CONNECTOR, 5/8 INCH	SEE CHART I
+ 12	1	O-RING	OV-11-113
13	1	TUBING CLAMP	R-118
+ 14	2	O-RING	OB-11-121
15	2	FLANGE	T-136
16	2	NUT, 3/8-16	N-146
17	1	BRACKET	T-135
18	1	NOZZLE	SEE CHART II
19	1	THROAT	SEE CHART II
20	2	BOLT, 3/8-16 X 4-1/2 LG HEX HD	N-145
+ 21	1	DIAPHRAGM BOLT ASSEMBLY	SEE NOTE 4

CHART I

ITEM	GAS	PART NO.
3	CHLORINE	U-236
	SULFUR DIOXIDE	U-236-1
4	CHLORINE	U-1683
	SULFUR DIOXIDE	U-917-1
11	CHLORINE	F-110
	SULFUR DIOXIDE	F-110-1

CHART II

ITEM	1-1/4 NPT	1-1/2 HOSE
18	E-187	E-190
19	E-189	E-188

CHART III

BACK PRESSURE AT EJECTOR	MARKING	GAS	ITEM 10	ITEM 21	KITS
0-20 PSIG (0-1.3 BAR)	L	CHLORINE	D-105	A-835-1	14431-1
		SULFUR DIOXIDE		BM-3572	14431-3
20-140 PSIG (1.3-9.5 BAR)	H	CHLORINE	U-1415 SEE NOTE 5	A-968	14431-2
		SULFUR DIOXIDE		BM-3573	14431-4

NOTES:

1 (+) INDICATE PARTS INCLUDED IN MAINTENANCE KITS.
ADDITIONAL PARTS AND QUANTITIES SHOULD BE CONSIDERED WHERE THE EQUIPMENT IS USED TO ITS FULLEST CAPABILITY OR WHERE LCOATED IN AN AREA REMOTE FROM CONVENIENT SERVICE.
TO ORDER A PREVENTIVE MAINTENANCE KIT, PARTS INDICATED (+), SEE CHART III

2. (*) NOZZLE AND THROAT SIZE APPEARS ON PART (SPECIFY WHEN ORDERING).

3. WHEN ORDERING PARTS, SPECIFY GAS FEEDER CAPACITY, MODEL NUMBER, AND SERIAL NUMBER.

4. KEY NUMBER 21 INCLUDES ITEMS 3, 4, 5, 6, AND 10. TO ORDER COMPLETE DIAPHRAGM BOLT ASSEMBLY (ITEM 21) SEE CHART III.

5 ITEM 10 (U-1415) CONSISTS OF TWO DIAPHRAGM SUPPORTS (ONE SET).

USING PARTS OTHER THAN GENUINE STWP PARTS:

- CAN RESULT IN MALFUNCTION OF THE EQUIPMENT AND POTENTIALLY CAUSE SERIOUS PERSONAL AND ENVIRONMENTAL HEALTH AND SAFETY HAZARDS

- WILL VOID YOUR EQUIPMENT WARRANTY

- WILL VOID YOUR LIABILITY CLAIMS TO STS

Severn Trent Services
3000 Advance Lane
Colmar, PA 18915 USA
Tel: 215-997-4000, Fax: 215-997-4062
Service Hotline: 800-523-6526

Warranty Policy for Severn Trent Water Purification, Inc. Products & Services

SEVERN TRENT SERVICES

Disinfection Products

1. **Scope of Warranty**

Severn Trent Water Purification, Inc. ("STWP") warrants to the original buyer, products that have been purchased for the purpose identified in our literature. Any warranty granted is void if products are used in any other manner. The Severn Trent Water Purification, Inc. products covered are:

- Gas dispensers for Cl2, SO2, NH3 and CO2 service, including related accessories, controls and safety equipment/instrumentation.
- Analytical Instrumentation & Water Quality Instrumentation.
- Gas Feed Systems (custom engineered equipment).
- Parts and Consumable Products for all the above products.
- UV Disinfection

2. **Standard Warranty**

The standard warranty for Severn Trent Water Purification, Inc. products is detailed in the company's "Terms and Conditions of Sale" (Document # 005.9000), which is the governing document for STWP Warranty Policy. In brief, this states that all warranties cover only material non-conformities or workmanship occurring in the course of manufacturing (not maintenance), and require return to the factory with transportation charges prepaid by the Buyer. More specifically:

A. **Products - Equipment that is listed in Severn Trent Water Purification, Inc. literature.**
These products are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning, whichever expires first. (See also Section 3 below.)

B. **Spare and/or Replacement parts**
Spare and / or replacement parts are warranted for twelve (12) months from the date of factory invoice

C. **Consumable Products**
Products (including chemical reagents) that are depleted during use and/or are date sensitive are considered Consumable Products. Consumable Products are to be stored and used according to STWP literature. Consumable Products are warranted against defects in material, formulation and workmanship occurring in the course of manufacturing up to the expiration and/or "use by" date. Instrument probes are warranted for a period of ninety (90) days from the date of factory invoice. To substantiate a failure in warranty, claimant must provide detailed information to the STWP factory. Any warranty granted by STWP is void if Consumable Products are used on products other than Severn Trent Water Purification, Inc. Also, if other than Severn Trent Water Purification, Inc. products are used on Severn Trent Water Purification, Inc. instruments, this may void the warranty.

D. **Equipment Manufactured by Others**
Products purchased from another manufacturer and supplied by STWP for the convenience of the customer, or as part of a system, carry the warranty of the original manufacturer. The customer should contact the original manufacturer directly about warranty issues; or STWP, upon request, will act as an agent when dealing with warranty issues. If STWP acts as an agent the customer must return equipment to the designated factory, shipping charges pre-paid. Customers' sole remedy is the original equipment manufacturer's warranty

E. **Systems - Custom Engineered Equipment**
STWP warrants all products that are integrated and arranged into a system (which conform to the functional intent of the customers specifications and has been approved by the customer) for performance to Severn Trent Water Purification, Inc. documented specifications. This warranty is for material defects in components and workmanship occurring in the course of our manufacturing.

All material defects in components and workmanship occurring in the course of commissioning and start-up not performed by STWP are not covered under this warranty. These systems are warranted for eighteen (18) months from the date of factory invoice, or twelve (12) months from the date of commissioning (requires written notice of customer's acceptance of product), which ever expires first The claimant must provide written notice (including details of functional operation during failure) of any defect(s) to substantiate the failure in warranty to the STWP factory

F. Field Service

STWP warrants all start-up work performed by our Field Service personnel for the same duration as our product and/or system warranty for material defects in components and workmanship occurring in the course of our work, but not the product or system application.

Customer is responsible for operating, maintaining (including changing consumables), and calibrating the product and/or system as described in the manual(s) provided by STWP.

All maintenance and/or repair performed by Severn Trent Water Purification, Inc. Field Service is warranted for a period of one-hundred and twenty (120) days from the date of service, or until the end of the original warranty period if service is performed during the warranty period, whichever is longer.

G. Factory Repair

STWP warrants that all factory repairs made to a product, under customer purchase order or warranty, will operate within documented technical specifications for a period of one-hundred and twenty (120) days from date of shipment, or until the end of the product's original warranty period, whichever is longer.

3. Extended Product Warranty

A. Series 200, Model 480 and Series NXT3000

The Vacuum Regulator ("VR") and Meter Assemblies within individual 200, 480 and NXT3000 chlorinators, ammoniators, carbonators or sulfonators with the original serial number intact are warranted for thirty-six (36) months from the date of factory invoice against defects in material and workmanship occurring in the course of manufacturing. (This extended warranty does not apply to Ejector assemblies.) The following parts incorporated in the Series 200, Model 480 and Series NXT3000 Vacuum Regulator assembly carry a Lifetime Warranty against any defects in material and workmanship:

Series 200 & Model 480 Series NXT3000-

Springs-Hastelloy C Inlet Body and Spring-Halar Diaphragm-Halar Diaphragm

4. Important Notes

STWP may require the return of defective/non-conforming products to its factory for examination and testing to verify non-conformity. A confirmed non-conformity, within the applicable warranty period, will be repaired or replaced as determined by STWP. Warranty does not include any installation, removal or freight expenses that might be associated with warranty repair or replacement

In situations where STWP agrees that it is not feasible for the claimant to return equipment to the factory, a purchase order will be required to dispatch a Service Technician and the claimant will only be invoiced if the product is found to be not warrantable.

STWP will make no allowance or reimbursement for repairs, alterations, replacements, or work of any kind done or ordered by others without prior written authorization by STWP.

The original buyer's sole remedy for breach of warranty for a product and/or service shall be at STWP's sole option to either repair or replace non-conforming product and/or service. If required, after evaluation and determination that a product is non-conforming by reason of manufacturing, STWP can refund the original buyer's purchase price for such product or service. Design improvements may be made without notice.

Design improvements may be made without notice

Represented by:

SEVERN TRENT SERVICES

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Decontamination Certificate

SEVERN TRENT SERVICES

Disinfection Products

THE FOLLOWING CLEANING PROCEDURES (SEE PAGE 2) MUST BE IMPLEMENTED AT THE CUSTOMER'S EXPENSE IF THE EQUIPMENT IS TO BE RETURNED TO THE FACTORY FOR SERVICE.

This sheet must be attached to the outside of each (if more than one) shipping carton, along with any applicable MSDS health/material handling recommendations.

FAILURE TO PROPERLY CLEAN THE EQUIPMENT OR ATTACH THE DECONTAMINATION CERTIFICATE TO THE OUTSIDE OF THE CARTON WILL RESULT IN THE EQUIPMENT BEING RETURNED UNREPAIRED.

Decontamination Statement

RA Number (WARRANTY & CREDIT RETURNS ONLY): ____________________

Equipment to be returned: ____________________

Model # : __________ Serial #: __________ PO#: __________ Date of PO: __________

Application: ☐ Waste Water ☐ Potable Water ☐ Industrial Process (MSDS Required)

List all chemical and process fluids in contact with the equipment.
Attach additional pages if necessary.

____

____

____

____

____

I hereby certify that the equipment being returned has been prepared for shipment and decontaminated in accordance with the procedure stated on page 2 of this document corresponding to the product that is being returned. The equipment is in compliance with OSHA and DOT regulations. This equipment poses no health or safety risks due to contamination.

By: ____________________ (Signature) ____________________ (Please Print)

Title: ____________________ Date: ____________________

Company Name: ____________________

Phone Number: ____________________ Fax Number: ____________________

Detailed Reason for Return: ____________________

____

____

CHLOR-A-VAC

- Flush out the vacuum connection of any residue chemicals.
- Remove all treatment facility process solids adhering to the CHLOR-A-VAC unit (including the inside of the vacuum housing) and the power cord with a pressure washer.
- Scrub the CHLOR-A-VAC and the power cord using a 10% solution of household bleach. Rinse thoroughly with potable water.
- Pack with appropriate restraints and packing materials to prevent shipping damage.

Liquid Feed

- Liquid Dosing Systems - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.
- Chlorine Dioxide Generators (All-Liquid Systems only) - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets - For chlorine gas type generators, consult factory.
- Tablet Feeders - Flush with potable water for a minimum of 15 minutes. Provide all applicable MSDS sheets.

Gas Feed

- Pull air through system for 15 minutes with rate valve fully open. Wipe down exterior surfaces.

Instrumentation

- Wipe down exterior surfaces.

Analyzers

- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Aztec Monitors

- Flush with potable water for a minimum of 15 minutes. Wipe down exterior surfaces.

Utraviolet Equipment

- Remove all treatment facility process solids to the unit with a pressure washer. Wipe down exterior surfaces. Package lamps and quartz separately.

pH probes

- Rinse with potable water

Dissolved Oxygen Probes

- Rinse probe and container with potable water. Wipe down exterior surfaces. Pack probe in container with potable water.

EST Equipment - (Included but not limited to Eductors, Steam Jets/Vacuum Systems, Scrubbers and Desuperheaters.) Due to the vast range of individually specific applications, an all encompassing decontamination procedure cannot apply. For this reason the end user bears responsibility for specific decontamination procedures. As a minimum the following shall apply:

- Remove and neutralize all acids and bases or other corrosive contaminants.
- Thoroughly purge equipment of all poisonous or noxious chemicals and irritants.
- Remove all foreign material, precipitate, fouling, scale, residue and/or noxious odor.

After the above has been completed, the equipment should be thoroughly rinsed using clean water and a mild detergent and be completely dried prior to packaging for return.

Design improvements may be made without notice.

Represented by:

SEVERN TRENT SERVICES

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Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

SEVERN TRENT SERVICES

Disinfection Products

Subject: Gas Feed Product Spare Parts

Dear Valued Customer,

As a user of Severn Trent Water Purification, Inc. products, you are a significant reason for the continued success of this company. All of us at STWP want to thank you for your business.

We appreciate this opportunity to present our views on "interchangeable" spare parts. Many of our smaller competitors, in an effort to gain market share, have developed "knock-off" spare parts for many of the products that we manufacture for gas feed applications. Since patent protection has expired, we have seen a significant attempt to flood the market with these "knock-off" parts

Obviously, STWP wants to protect its' spare parts business but we feel that there are significant issues that you should consider.

We believe municipal procurement practices which call for sourcing from the lowest priced supplier serve the public well. But lower priced "knock-off" parts can seriously endanger the welfare of the public as well as your operators.

We are committed to providing the highest quality parts at competitive prices. As a manufacturer of gas feed equipment with over 45 years of experience, we have an enviable safety record This record has been earned through meticulous attention to design, materials and quality. You may not know that we pioneered the all-vacuum method of gas feed and that we have been certified to the worldwide ISO 9001 quality standard since 1991.

Using parts other than genuine STWP parts:

- ***can result in malfunction of the equipment and potentially cause serious personal and environmental health and safety hazards***
- ***will void your equipment warranty***
- ***will void your liability claims to STWP***

We are extremely concerned about these issues and believe you are as well. Our recommendation is that your procurement policy for gas feed parts and equipment require that:

- ***replacement/spare parts always be sourced from the original manufacturer, and***
- ***you have evidence of substantial product liability insurance***

These measures preserve product integrity and safety, and your right of recourse in the event of an occurrence.

With the current public and various safety agency concerns, we strongly believe that these are critical issues for our industry, our customers and their employees.

Should you have any questions or comments, I would very much like to hear from you. You can email me at jblundi@severntrentservices.com or call me at 215 997 4065

James R Blundi
irector
Gas Feed and Instrumentation

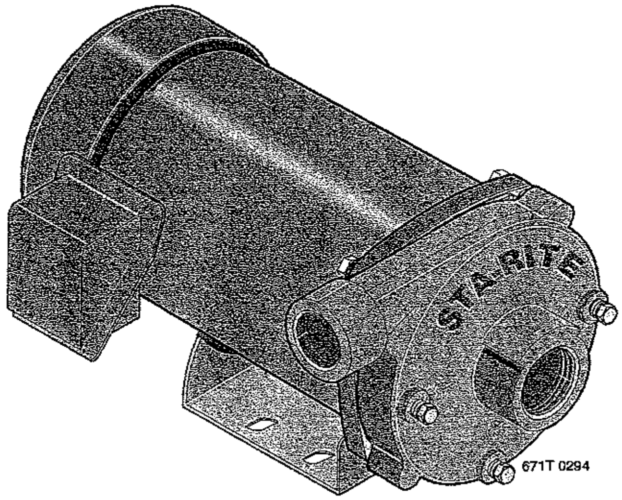
Severn Trent Water Purification, Inc. • 3000 Advance Lane • Colmar, PA 18915 • Tel 215 997 4000
Fax 215 997 4062 • *www.severntrentservices.com*

STA-RITE®

OWNER'S MANUAL

INSTALLATION AND OPERATING INSTRUCTIONS
REPAIR PARTS LIST

60 CYCLE "J" and "JB" SERIES CENTRIFUGAL PUMPS WITH TEFC MOTORS



MODELS

H.P.	MEDIUM HEAD MODELS			
1/3	JMBT-56	–	JBMBT-56S	–
1/2	JMCT-56	JMC3T-56	JBMCT-56S	JBMC3T-56S
3/4	JMDT-57	JMD3T-57	–	JBMD3T-57S
1	JMET-58	JME3T-58	JBMET-58S	JBME3T-58S
1-1/2	JMFT-40	JMF3T-40	JBMFT-40S	JBMF3T-40S
2	JMGT-41	JMG3T-41	JBMGT-41S	JBMG3T-41S
2-1/2	–	–	JBMMGT-59S	JBMMG3T-59S

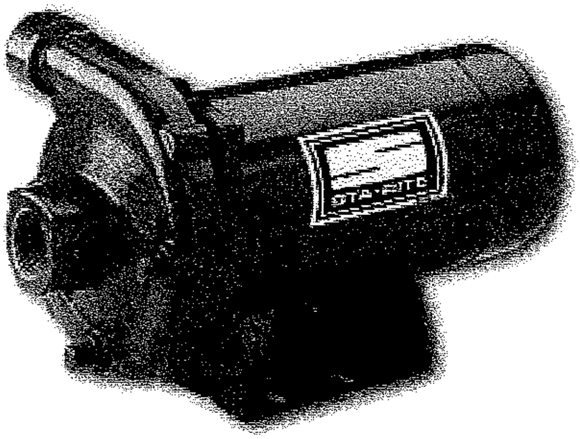
H.P.	HIGH HEAD MODELS				
1/3	JHBT-61H	–	JBHBT-61S	–	–
1/2	JHCT-61H	JHC3T-61H	JBHCT-61S	JBHC3T-61S	–
3/4	JHDT-62H	JHD3T-62H	JBHDT-62S	JBHD3T-62S	JBH2DT-62S
1	JHET-63H	JHE3T-63H	JBHET-63S	JBHE3T-63S	–
1-1/2	JHFT-51H	JHF3T-51H	JBHFT-51S	JBHF3T-51S	–
2	JHGT-52H	JHG3T-52H	JBHGT-52S	JBHG3T-52S	–
2-1/2	–	JHHG3T-53H	JBHHGT-53S	JBHHG3T-53S	–

STA-RITE INDUSTRIES, INC., DELAVAN, WISCONSIN 53115

S257 (Rev. 5/23/05)

STA-RITE®

general purpose centrifugal pumps



J Series is Listed to UL Standards for Safety by Underwriters Laboratories Inc. (UL).
JB Series is UL Listed for water temperatures up to 175°F.

J/JB SERIES

FEATURES

1/3 through 2-1/2 HP – High head and medium head models, with heavy-duty motors, easy service design and four-position discharge.

Drain Port – Provided for easy winterizing.

Medium Head Models – Deliver up to 110' of head with capacities to 140 GPM.

High Head Models – Deliver up to 140' of head with capacities to 90 GPM.

Easy Serviceability – All models include replaceable wear ring and feature back pull-out design.

J Series with Noryl® Impellers – Abrasion-resistant for normal applications with working temperatures to 140°F.

JB Series with Silicon Bronze – JB pumps equipped with shaft seals rated for temperatures to 225°F.

The J/JB Series Pumps have a heavy-duty cast iron construction and are offered in high and medium head models, with Noryl® or silicon bronze impeller.

APPLICATIONS

- **Water systems and sprinkling**..... for homes, farms and industry.

SPECIFICATIONS

Body and Seal Plate – Close-grained cast iron

Base – Steel 10 gauge

Impeller – J Series – Noryl®

Impeller – JB Series – Silicon bronze

Shaft – 416 stainless steel

Mechanical Seal – Carbon/ceramic, Buna-N

ORDERING INFORMATION

HIGH HEAD

Catalog Number: Noryl® Impeller	Catalog Number: Silicon Bronze Impeller	HP	Pipe Tapping Sizes: Suct.	Pipe Tapping Sizes: Disch.	Motor Voltage	Phase	Max. Load Amps	Approx. Wt. Lbs.
JHB	JBHB	1/3	1-1/4"	1"	115	1	9.41	38
JHC	JBHC	1/2	1-1/4"	1"	115/230	1	8.8/4.4	39
JHC3	JBHC3		1-1/4"	1"	208-230/460	3	2.3/1.15	39
JHD	JBHD	3/4	1-1/4"	1"	115/230	1	12.2/6.1	42
JHD3	JBHD3		1-1/4"	1"	208-230/460	3	3.1/1.55	42
JHE	JBHE	1	1-1/4"	1"	115/230	1	14.8/7.4	45
JHE3	JBHE3		1-1/4"	1"	208-230/460	3	3.6/1.8	45
JHF	JBHF	1-1/2	1-1/4"	1"	115/230	1	19.2/9.6	49
JHF3	JBHF3		1-1/4"	1"	208-230/460	3	4.7/2.35	49
JHG	JBHG	2	1-1/2"	1-1/4"	230	1	12.0	69
JHG3	JBHG3		1-1/2"	1-1/4"	208-230/460	3	6.8/3.4	69
JHHG	JBHHG	2-1/2	2"	1-1/2"	230	1	12.0	74
JHHG3	JBHHG3		2"	1-1/2"	208-230/460	3	8.5/4.25	74

MEDIUM HEAD

Catalog Number: Noryl® Impeller	Catalog Number: Silicon Bronze Impeller	HP	Pipe Tapping Sizes: Suct.	Pipe Tapping Sizes: Disch.	Motor Voltage	Phase	Max. Load Amps	Approx. Wt. Lbs.
JMB	JBMB	1/3	1-1/4"	1"	115	1	9.41	38
JMC	JBMC	1/2	1-1/4"	1"	115/230	1	8.8/4.4	39
JMC3	JBMC3		1-1/4"	1"	208-230/460	3	2.3/1.15	39
JMD	JBMD	3/4	1-1/4"	1"	115/230	1	12.2/6.1	42
JMD3	JBMD3		1-1/4"	1"	208-230/460	3	3.1/1.55	42
JME	JBME	1	1-1/2"	1-1/4"	115/230	1	14.8/7.4	43
JME3	JBME3		1-1/2"	1-1/4"	208-230/460	3	3.6/1.8	43
JMF	JBMF	1-1/2	1-1/2"	1-1/4"	115/230	1	19.2/9.6	54
JMF3	JBMF3		1-1/2"	1-1/4"	208-230/460	3	4.7/2.35	54
JMG	JBMG	2	1-1/2"	1-1/4"	230	1	12.0	66
JMG3	JBMG3		1-1/2"	1-1/4"	208-230/460	3	6.8/3.4	66
—	JBMMG	2-1/2	2"	1-1/2"	230	1	12.0	74
—	JBMMG3		2"	1-1/2"	208-230/460	3	8.5/4.25	74

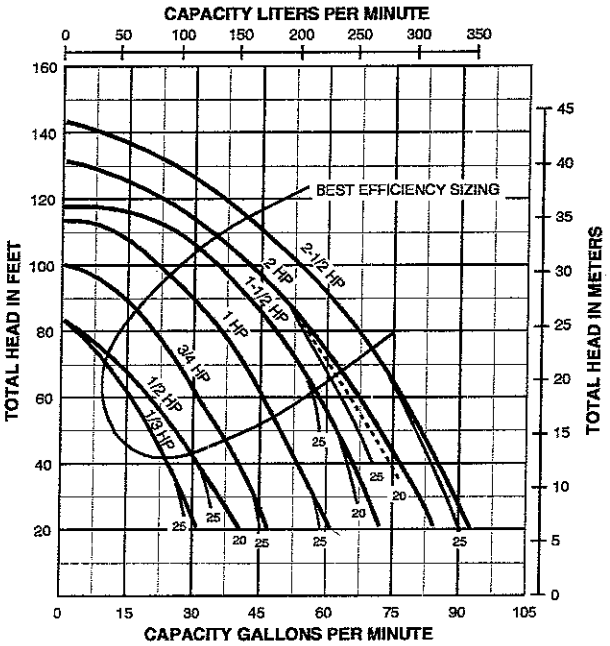
Noryl® is a registered trademark of General Electric Co. PRO-Source™ is a trademark of WICOR Industries.
In order to provide the best products possible, specifications are subject to change.

STA-RITE

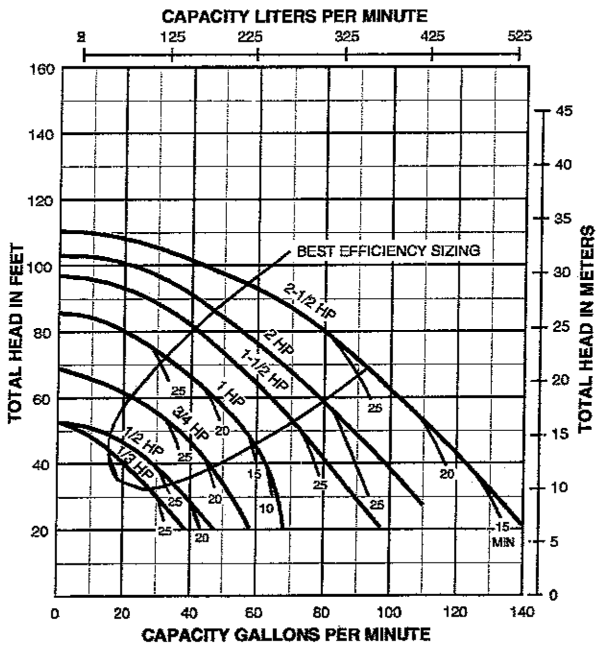
general purpose centrifugal pumps

PUMP PERFORMANCE

High Head



Medium Head



NOTE: Dotted lines indicate performance reduction at high suction lift.

PUMP PERFORMANCE *(Capacity in Gallons Per Minute)*

HIGH HEAD

HP	Discharge Pressure PSI	Discharge Pressure Feet Head	Dynamic Suction Lift 5'	10'	15'	20'	25'
1/3	10	23.1	—	26	24	22	20
	20	46.2	20	18	15	11	10
	30	69.3	6	—	—	—	—
1/2	10	23.1	—	34	32	29	26
	20	46.2	25	21	18	15	11
	30	69.3	10	—	—	—	—
3/4	10	23.1	—	—	42	39	37
	20	46.2	35	32	30	28	26
	30	69.3	24	22	19	15	10
1	20	46.2	48	46	45	43	40
	30	69.3	38	35	31	28	25
	40	92.4	23	20	15	—	—
1-1/2	20	46.2	62	60	58	55	52
	30	69.3	50	48	44	40	37
	40	92.4	37	32	29	22	—
2	20	46.2	71	68	66	62	60
	30	69.3	60	57	52	59	45
	40	92.4	45	40	36	31	24
	50	115.5	22	15	—	—	—
2-1/2	20	46.2	81	79	76	74	71
	30	69.3	69	67	63	60	56
	40	92.4	56	51	47	44	38
	50	115.5	33	30	22	15	—

Tested and rated in accordance with Water Systems Council Standards.

NOTE: Pumps installed with a PRO-Source™ tank require a 100 PSI relief valve. Pumps with a conventional tank require a 75 PSI relief valve. Relief valve must be capable of relieving entire flow of pump at relief pressure.

STA-RITE

general purpose centrifugal pumps

PUMP PERFORMANCE *(Capacity in Gallons Per Minute)*

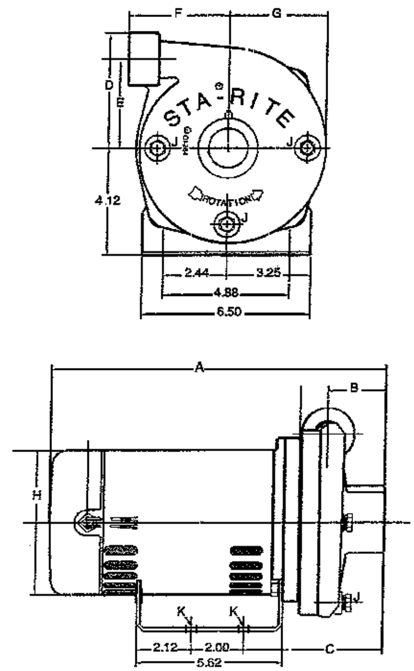
MEDIUM HEAD

	Discharge Pressure		Dynamic Suction Lift				
HP	PSI	Feet Head	5'	10'	15'	20'	25'
1/3	10	23.1	32	27	18	—	—
	20	46.2	—	—	—	—	—
1/2	10	23.1	40	37	32	27	17
	20	46.2	—	—	—	—	—
3/4	10	23.1	—	50	46	42	32
	20	46.2	37	29	21	—	—
1	20	46.2	54	51	44	40	33
	30	69.3	33	28	18	—	—
1-1/2	20	46.2	71	69	62	57	51
	30	69.3	52	47	34	30	20
2	20	46.2	88	84	78	70	66
	30	69.3	67	60	50	45	40
	40	92.4	25	13	—	—	—
2-1/2	20	46.2	111	106	101	95	90
	30	69.3	90	83	77	70	60
	40	92.4	46	38	20	—	—

Tested and rated in accordance with Water Systems Council Standards.

NOTE: Pumps installed with a PRO-Source™ tank require a 100 PSI relief valve. Pumps with a conventional tank require a 75 PSI relief valve. Relief valve must be capable of relieving entire flow of pump at relief pressure.

OUTLINE DIMENSIONS



Dimensions (in inches) are for estimating purposes only.

DIMENSIONS *(In Inches)*

HIGH HEAD

HP	NPT Suct.	NPT Disch.	ECII (1 Phase)	A (3 Phase)	B	C	D	E	F	G	H	NPT J	K
1/3	1-1/4	1	13	13-3/8	2-1/16	5-9/16	4-1/2	3-7/16	3-7/8	3-15/16	5-5/8	1/4	3/8 Dia.
1/2	1-1/4	1	11-21/32	13-3/8	2-1/16	5-9/16	4-1/2	3-7/16	3-7/8	3-15/16	5-5/8	1/4	3/8 Dia.
3/4	1-1/4	1	11-25/32	13-3/8	2-1/16	5-9/16	4-1/2	3-7/16	3-7/8	3-15/16	5-5/8	1/4	3/8 Dia.
1	1-1/4	1	12-25/32	13-7/8	2-1/16	5-9/16	4-1/2	3-7/16	3-7/8	3-15/16	5-5/8	1/4	3/8 Dia.
1-1/2	1-1/4	1	13-39/64	14-3/8	2-1/16	5-9/16	4-1/2	3-7/16	3-7/8	3-15/16	5-5/8	1/4	3/8 Dia.
2	1-1/2	1-1/4	16-3/4	16-15/16	2-13/16	6-5/16	4-27/32	3-13/32	4-5/8	4	6-7/16	1/4	3/8 Dia.
2-1/2	2	1-1/2	17-3/4	17-1/4	2-13/16	6-5/16	4-27/32	3-13/32	4-5/8	4	6-7/16	1/4	3/8 Dia.

MEDIUM HEAD

HP	NPT Suct.	NPT Disch.	ECII (1 Phase)	A (3 Phase)	B	C	D	E	F	G	H	NPT J	K
1/3	1-1/4	1	12-9/16	12-15/16	1-7/16	5-1/8	4-7/16	3-1/4	2-1/4	3-1/4	5-5/8	1/4	3/8 Dia.
1/2	1-1/4	1	11-7/32	12-15/16	1-7/16	5-1/8	4-7/16	3-1/4	2-1/4	3-1/4	5-5/8	1/4	3/8 Dia.
3/4	1-1/4	1	11-31/32	12-15/16	1-7/16	5-1/8	4-7/16	3-1/4	2-1/4	3-1/4	5-5/8	1/4	3/8 Dia.
1	1-1/2	1-1/4	12-11/32	13-7/16	1-7/16	5-1/8	4-7/16	3-1/4	2-1/4	3-1/4	5-5/8	1/4	3/8 Dia.
1-1/2	1-1/2	1-1/4	13-25/32	14-9/16	2	5-3/4	4-13/16	3-1/2	4-1/4	3-15/16	5-5/8	1/4	3/8 Dia.
2	1-1/2	1-1/4	16-3/16	16-3/8	2	5-3/4	4-13/16	3-1/2	4-1/4	3-15/16	6-7/16	1/4	3/8 Dia.
2-1/2	2	1-1/2	17-3/16	16-11/16	2	5-3/4	4-13/16	3-1/2	4-1/4	3-15/16	6-7/16	1/4	3/8 Dia.

Appendix B

NPDES Permit

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §§1251 et seq.; the "CWA"),

Department of the Army
Cold Regions Research and Engineering Laboratory

is authorized to discharge from a facility located at

72 Lyme Road
Hanover, New Hampshire 03755

to receiving water named

Connecticut River (Hydrologic Code; 01080104)

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit is effective May 1, 2005.

This permit and the authorization to discharge expires at midnight, five (5) years from the effective date.

This permit supersedes the permit issued on October 25, 1973 and modified on March 20, 1975 and February 26, 1976.

This permit consists of 9 pages in Part I including effluent limitations and monitoring requirements; Attachment A (11 pages); and 35 pages in Part II including General Conditions and Definitions.

Signed this 17 day of February, 2005

Linda M. Murphy

Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency
New England Region
Boston, Massachusetts

PART I.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date of this Permit and lasting through the expiration date, the Permittee is authorized to discharge non-contact cooling water from outfall Serial Number 001 into the Connecticut River. Such discharges shall be limited and monitored by the Permittee as specified below. Samples taken in compliance with the monitoring requirements specified below shall be taken at a location that provides a representative analysis of the effluent[1].

Effluent Characteristic	Discharge Limitations		Monitoring Requirement	
	Average Monthly	Maximum Daily	Measurement Frequency	Sample Type
Flow; MGD	Report	1.9	Continuous	Calculation or other approved method[2]
Temperature, °C	Report	24 (75°F)	3/Week	Grab
Trichloroethylene (TCE), ug/l	———	5.0	1/Month	Grab[3]
pH[4], Standard Units	6.5-8.0		3/Week	Grab

PART I.A.1.a (Continued)

Effluent Characteristic	Discharge Limitations	Monitoring Requirement	
		Measurement Frequency	Sample Type
Whole Effluent Toxicity[5]			
LC50[6,7]; in percent	Report	2 Tests	24-Hour Composite
C-NOEC[7,8]; in percent	Report	2 Tests	24-Hour Composite
Ammonia Nitrogen as Nitrogen; mg/l[9]	Report	2 Tests	24-Hour Composite
Hardness; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Aluminum; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Cadmium; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Chromium; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Copper; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Nickel; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Lead; mg/l[9]	Report	2 Tests	24-Hour Composite
Total Recoverable Zinc; mg/l[9]	Report	2 Tests	24-Hour Composite

(Note: See page 4-5 for explanation of footnotes.)

EXPLANATION OF FOOTNOTES TO PART I.A.1.a ON PAGE 2

(1) Samples taken in compliance with the monitoring requirements shall be taken at a location prior to any commingling with storm water discharges.

(2) Non-contact cooling water flow shall be determined by subtracting the quantity of metered Trichloroethylene backwash water discharged to Hanover's POTW from the quantity of metered source waters (wells) pumped to the facility's various non-contact cooling water (NCCW) systems (heat exchangers). All source waters pumped to the various NCCW systems and backwash flows discharged to the POTW shall be measured continuously and recorded on totalizers. To obtain approval for an alternative method of flow reporting, the permittee shall submit a written description of the proposed method to EPA-New England and receive written authorization via certified letter.

(3) Trichloroethylene shall be sampled directly after discharge from the Trichloroethylene treatment system.

(4) This is a State Certification requirement. pH shall be in the range of 6.5 to 8.0 standard units (S.U.).

(5) The Permittee shall conduct two chronic (and modified acute) survival and reproduction WET tests on effluent samples using two species, Daphnid (Ceriodaphnia dubia) and Fathead Minnow (Pimephales promelas) following the protocol listed in ATTACHMENT A, *Freshwater Chronic and Modified Acute Toxicity Test Procedure and Protocol*, (dated December 1995). The first WET test shall be completed within 90 days after the receipt of the issued Permit. The second test shall be completed 180 days after the first test. Toxicity tests results shall be submitted to the EPA and NHDES-WD.

(6) LC50 is the concentration of wastewater (effluent) causing mortality to 50 percent (%) of the test organisms. See ATTACHMENT A (VII. TOXICITY TEST DATA ANALYSIS) on page A-9 for additional clarification.

(7) This Permit may be modified, or alternatively, revoked and reissued to incorporate additional toxicity testing requirements, including chemical specific limits, if the

results of the WET tests indicate the discharge exceeds any State of New Hampshire water quality criterion. Results from these toxicity tests are considered "New Information" and the Permit may be modified as provided in 40 CFR §122.62(a)(2).

(8) C-NOEC (Chronic-No Observed Effect Concentration) is defined as the highest concentration of toxicant or effluent to which organisms are exposed in a life-cycle or partial life-cycle test which causes no adverse effect on growth, survival, or reproduction at a specific time of observation as determined from hypothesis testing where the test results (growth, survival, and/or reproduction) exhibit a linear dose-response relationship. However, where the test results do not exhibit a linear dose-response relationship, report the lowest concentration where there is no observable effect. See ATTACHMENT A (VII. TOXICITY TEST DATA ANALYSIS) on page A-9 for additional clarification.

(9) For each WET test the Permittee shall report on the appropriate Discharge Monitoring Report (DMR) the concentrations of Ammonia Nitrogen as Nitrogen, Hardness, and Total Recoverable Aluminum, Cadmium, Chromium, Copper, Nickel, Lead and Zinc found in the 100 percent effluent sample. All these aforementioned chemical parameters shall be determined to at least the Minimum Quantification Level (MLs) shown in Attachment A and B; Section VI. Chemical Analysis, or as amended. The Permittee should also note that all chemical parameter results must still be reported in the appropriate WET test toxicity report.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (continued)

2. The discharge shall not cause a violation of the water quality standards of the receiving water

3. The discharge shall remain free from pollutants in concentrations or combinations that settle to form harmful deposits, float as foam, debris, scum or other visible pollutants. It shall remain free from pollutants which produce odor, color, taste or turbidity in the receiving waters which is not naturally occurring and would render it unsuitable for its designated uses.

4. The Permittee shall not discharge into the receiving water any pollutant or combination of pollutants in toxic amounts. No biocides, including chlorine compounds, may be used without explicit approval from the EPA and New Hampshire Department of Environmental Services - Water Division (NHDES-WD).

5. The discharge shall not cause the turbidity in the receiving water to exceed naturally occurring conditions by 10 Nephelometric Turbidity Units (NTU) as specified in Env-WS 432.13.

6. The Regional Administrator reserves the right to modify this Permit to incorporate additional Chemical Specific and/or Toxicity Testing requirements including limits if results of any toxicity tests of the receiving waters in the vicinity of the Permittee's outfall indicates the Permittee's discharge causes or has a "reasonable potential" to cause an exceedance of any water-quality criterion. Results from these toxicity tests are considered "new information" and the Permit may be modified as provided at 40 CFR §122.62(a)(2).

7. All existing manufacturing, commercial, mining, and silvicultural dischargers in accordance with 40 CFR §122.42 must notify the EPA and NHDES-WD as soon as they know or have reason to believe (as summarized):

   a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant (as defined in 40 CFR §122.2) which is not limited in the Permit, if that discharge will exceed the highest of the following "notification levels":

      (1) One hundred micrograms per liter (100 ug/L);

      (2) Two hundred micrograms per liter (200 ug/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

      (3) Five (5) times the maximum concentration value reported for that pollutant in the Permit application in accordance with 40 CFR

§122.21(g)(7); or

(4) Any other notification level established by the Director in accordance with 40 CFR §122.44(f).

b. That any activity has occurred or will occur which would result in the discharge, on a non-routine or infrequent basis, of any toxic pollutant which is not limited in the Permit, if that discharge will exceed the highest of the following "notification levels":

(1) Five hundred micrograms per liter (500 ug/L);

(2) One milligram per liter (1 mg/L) for antimony;

(3) Ten (10) times the maximum concentration value reported for that pollutant in the Permit application in accordance with 40 CFR §122.21(g)(7); or

(4) Any other notification level established by the Director in accordance with 40 CFR §122.44(f).

c. That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the Permit application.

8. This Permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable standard or limitation promulgated or approved under Sections 301(b)(2)(C) and (d), 304(b)(2), and 307(a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

a. Contains different conditions or is otherwise more stringent than the effluent limitation in the Permit; or

b. Controls any pollutants not limited in the Permit.

The Permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

B. MONITORING AND REPORTING

Monitoring results shall be summarized for each calendar month and reported on separate Discharge Monitoring Report Form(s) (DMRs) postmarked no later than the 15th day of the month following the completed reporting period.

Signed and Dated original DMRs and all other reports required herein, shall be submitted to the Director at the following address:

U.S. Environmental Protection Agency
Water Technical Unit (SEW)
P.O. Box 8127
Boston, Massachusetts 02114-8127

Duplicate signed copies of all reports required herein shall be submitted to the State at:

New Hampshire Department of Environmental Services
Water Division
Wastewater Engineering Bureau
29 Hazen Drive, P.O. Box 95
Concord, New Hampshire 03302-0095

All verbal reports or notifications shall be made to both EPA and NHDES-WD.

C. SPECIAL CONDITIONS

pH Limit Adjustment

The permittee may submit a written request to the EPA-New England requesting a change in the permitted pH limit range to be not less restrictive than 6.0 to 9.0 Standard Units. The permittee's written request must include the State's approval letter containing an original signature (no copies). The State's letter shall state that the permittee has demonstrated to the State's satisfaction that as long as discharges to the receiving water from a specific outfall are within a specific numeric pH range the naturally occurring receiving water pH will be unaltered. That letter must specify for each outfall the associated numeric pH limit range. Until written notice is received by certified mail from the EPA-New England indicating the pH limit range has been changed, the permittee is required to meet the permitted pH limit range in the respective permit.

D. STATE PERMIT CONDITIONS

1. The permittee shall comply with the following conditions which are included as State Certification requirements. The pH range of 6.5-8.0 Standard Units (S.U.) must be achieved in the final effluent unless the permittee can demonstrate to NHDES-WD: (1) that the range should be widened due to naturally occurring conditions in the receiving water or (2) that the naturally occurring receiving water pH is not significantly altered by the permittee's discharge. The scope of any demonstration project must receive prior approval from NHDES-WD. In no case, shall the above procedure result in pH limits outside of the range of 6.0 to 9.0 S.U., which is the pH range consistently applied in National Effluent Limitation Guidelines.

2. This NPDES Discharge Permit is issued by the U.S. Environmental Protection Agency (EPA) under Federal and State law. Upon final issuance by the federal EPA, the New Hampshire Department of Environmental Services, Water Supply and Pollution Control Division may adopt this Permit, including all terms and conditions, as a state discharge Permit pursuant to RSA 485-A:13.

   Each Agency shall have the independent right to enforce the terms and conditions of this Permit. Any modification, suspension or revocation of this Permit shall be effective only with respect to the Agency taking such action, and shall not affect the validity or status of the Permit as issued by the other Agency, unless and until each Agency has concurred in writing with such modification, suspension or revocation. In the event any portion of this Permit is declared invalid, illegal or otherwise issued in violation of State law, such Permit shall remain in full force and effect under Federal law as an NPDES Permit issued by the U.S. Environmental Protection Agency. In the event this Permit is declared invalid, illegal or otherwise issued in violation of Federal law, this Permit, if adopted as a state Permit, shall remain in full force and effect under State law as a permit issued by the State of New Hampshire.

ATTACHMENT A

FRESHWATER CHRONIC and MODIFIED ACUTE

TOXICITY TEST PROCEDURE AND PROTOCOL

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable chronic and modified acute toxicity tests on three samples collected during the test period. The following tests shall be performed in accordance with the appropriate test protocols described below:

- **Daphnid (Ceriodaphnia dubia) Survival and Reproduction Test.**
- **Fathead Minnow (Pimephales promelas) Larval Growth and Survival Test.**

Chronic and acute toxicity data shall be reported as outlined in Section VIII. The chronic fathead minnow and daphnid tests can be used to calculate an LC50 at the end of 48 hours of exposure when both an acute (LC50) and a chronic (C-NOEC) test is specified in the permit.

II. METHODS

Methods to follow are those recommended by EPA in:

Lewis, P.A. et al. Short Term Methods For Estimating The Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, Third Edition. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH. July 1994, EPA/600/4-91/002.

Any exceptions are stated herein.

III. SAMPLE COLLECTION

For each sampling event, three discharge samples shall be collected. Fresh samples are necessary for Days 1, 3, and 5 (see Section V. for holding times). The initial sample is used to start the test on Day 1, and for test solution renewal on Day 2. The second sample is collected for use at the start of Day 3, and for renewal on Day 4. The third sample is used for renewal on Days 5, 6, and 7 (or until termination for the Ceriodaphnia dubia test). The initial (Day 1) sample will be analyzed chemically (see Section VI). Day 3 and 5 samples will be held until test completion. If either the Day 3 or 5 renewal sample is of sufficient potency to cause lethality to 50 percent or more test organisms in any of the dilutions for either species, then a chemical analysis shall be performed on the appropriate sample(s) as well.

Aliquots shall be split from the samples, containerized and preserved (as per 40 CFR Part 136) for chemical and physical analyses. The remaining samples shall be measured for total residual chlorine and dechlorinated (if detected) in the laboratory using sodium thiosulfate for subsequent toxicity testing. (Note that EPA approved test methods require that samples collected for metals analyses be preserved immediately after collection.) Grab samples must be used for pH, temperature, and total residual chlorine (as per 40 CFR Part 122.21).

Standard Methods for the Examination of Water and Wastewater also describes dechlorination of samples (APHA, 1992). Dechlorination can be achieved using a ratio of 6.7 mg/L anhydrous sodium thiosulfate to reduce 1 mg/L chlorine. A thiosulfate control (maximum amount of thiosulfate in lab control or receiving water) should also be run.

All samples held overnight shall be refrigerated at 4°C.

IV. DILUTION WATER

Grab samples of dilution water used for chronic toxicity testing shall be collected from the receiving water at a point upstream of the discharge free from toxicity or other sources of contamination. Avoid collecting near areas of obvious road or agricultural runoff, storm sewers or other point source discharges. An additional control (0% effluent) of a standard laboratory water of known quality shall also be tested.

If the receiving water diluent is found to be, or suspected to be toxic or unreliable, an alternate standard dilution water of known quality with a hardness, pH, conductivity, alkalinity, organic carbon, and total suspended solids similar to that of the receiving water may be substituted **AFTER RECEIVING WRITTEN APPROVAL FROM THE PERMIT ISSUING AGENCY(S)**. Written requests for use of an alternate dilution water should be mailed with supporting documentation to the following address:

Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency - New England
1 Congress Street
Mail Code: CPA
Boston, Massachusetts 02114-2023

It may prove beneficial to the permittee to have the proposed dilution water source screened for suitability prior to toxicity testing. EPA strongly urges that screening be done prior to set up of a full definitive toxicity test any time there is question about the dilution water's ability to support acceptable performance as outlined in the 'test acceptability' section of the protocol. See Section 7 of EPA/600/4-89/001 for further information.

V. TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA

EPA New England requires that fathead minnow tests be performed using four (not three) replicates of each control and effluent concentration because the non-parametric statistical tests cannot be used with data from only three replicates. Also, if a reference toxicant test was being performed concurrently with an effluent or receiving water test and fails, both tests must be repeated.

The following two tables summarize the accepted Daphnid and Fathead Minnow toxicity test conditions and test acceptability criteria:

EPA NEW ENGLAND RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE DAPHNID, *Ceriodaphnia dubia*, SURVIVAL AND REPRODUCTION TEST[1]

1.	Test type:	Static, renewal
2.	Temperature (°C):	25 ± 1°C
3.	Light quality:	Ambient laboratory
4.	Photo-period	16 hr. light, 8 hr. dark
5.	Test chamber size:	30 ml
6.	Test solution volume:	15 ml
7.	Renewal of test solutions:	Daily using most recently collected sample.
8.	Age of test organisms:	Less than 24 hr.; and all released within an 8 hr.
9.	Number of neonates per test chamber:	1
10.	Number of replicate per test chambers:	10
11.	Total number of neonates per test:	10

12.	Feeding regime:	Feed 0.1 ml each of YCT and concentrated algal
13.	Aeration:	None
14.	Dilution water[2]:	Receiving water, other surface water, synthetic soft water adjusted to the hardness and alkalinity of the receiving water (prepared using either Millipore Milli-Q® or equivalent deionized water and reagent grade chemicals
15.	Effluent Concentrations[3]:	5 effluent concentrations and a control. An additional dilution at the permitted effluent concentration (% effluent)
16.	Dilution factor:	> 0.5
17.	Test duration:	Until 60% of control females have three broods (generally 7 days and a
18.	End points:	Survival and reproduction
19.	Test acceptability:	80% or greater survival and an average of 15 or more young/surviving female in the control solutions. At least 60% of surviving

20. Sampling requirements — For on-site tests, samples are collected daily and used within 24 hr. of the time they are removed from the sampling device. For off-site tests a minimum of three samples are collected (i.e. days 1, 3, 5) and

21. Sample volume required: — Minimum 1 liter/day

Footnotes:

(1) Adapted from EPA/600/4-91/002.

(2) Standard dilution water must have hardness requirements to generally reflect characteristics of the receiving water.

(3) When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

EPA NEW ENGLAND RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE FATHEAD MINNOW (*Pimephales prommelas*) LARVAL SURVIVAL AND GROWTH TEST[1]

1.	Test type:	Static, renewal
2.	Temperature (°C):	25 ± 1°C
3.	Light quality:	Ambient laboratory illumination
4.	Photo-period:	16 hr. light, 8 hr. dark
5.	Test chamber size:	500 ml minimum
6.	Test solution volume:	Minimum 250 ml/replicate
7.	Renewal of test	Daily using most recently
8.	Age of test organisms:	Newly hatched larvae less than 24
9.	No. larvae/test chamber	15 (minimum of 10)

10.	No. of replicate	4
11.	No. of larvae/ concentration:	60 (minimum of 40)
12.	Feeding regime:	Feed 0.1 g newly hatched, distilled water-rinsed *Artemia nauplii* at least 3 times daily at 4 hr. intervals or, as a minimum, 0.15 g twice daily, 6 hrs. between feedings (at the beginning of the work day prior to renewal, and at the end of the work day following renewal). Sufficient larvae are added to provide an excess.
13.	Cleaning:	Siphon daily, immediately before test solution renewal.
14.	Aeration:	None, unless dissolved oxygen (D.O.) concentration falls below 4.0 mg/L. Rate should be less than 100 bubbles/min.
15.	Dilution water:[2]	Receiving water, other surface water, synthetic soft water adjusted to the hardness and alkalinity of the receiving water (prepared using either Millipore Milli-Q® or equivalent deionized and reagent grade chemicals according to EPA chronic toxicity test manual) or deionized water combined with mineral water to appropriate hardness.
16.	Effluent concentrations:[3]	5 and a control. An additional dilution at the permitted effluent concentration (% effluent) is required if it is not included in
17.	Dilution factor:	≥ 0.5

18. Test duration: 7 days

19. End points: Survival and growth (weight)

20. Test acceptability: 80% or greater survival in controls: average dry weight per control larvae equals or exceeds

21. Sampling requirements: For on-site tests samples are collected and used within 24 hours of the time they are removed from the sampling device. For off-site tests a minimum of three samples are collected (i.e. days 1, 3, 5)

22. Sample volume required: Minimum 2.5 liters/day

Footnotes:
(1) Adapted from EPA/600/4-91/002.
(2) Standard dilution water must have hardness requirements to generally reflect characteristics of the receiving water.
(3) When receiving water is used for dilution, an additional control made up of standard laboratory or culture water (0% effluent) is required.

VI. CHEMICAL ANALYSIS

As part of each daily renewal procedure, pH, specific conductance, dissolved oxygen, and temperature must be measured at the beginning and end of each 24-hour period in each dilution and the controls. It is also recommended that total alkalinity and total hardness be measured in the control and highest effluent concentration on the Day 1, 3, and 5 samples. The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Min. Quatification
Hardness[1]	X	X	0.5
Alkalinity	X	X	2.0
pH	X	X	--
Specific Conductance	X	X	--
Total Solids & Suspended Solids	X	X	--
Ammonia	X	X	0.1
Total Organic Carbon	X	X	0.5

ATTACHMENT A

Parameter	Effluent	Diluent	Min. Quatification
Total Residual Chlorine (TRC)[2]	X	X	0.05
Dissolved Oxygen	X	X	1.0
Total Metals			
Cd	X		0.001
Cr	X		0.005
Pb	X	X	0.005
Cu	X	X	0.0025
Zn	X	X	0.0025
Ni	X	X	0.004
Al	X	X	0.02
Mg, Ca	X	X	0.05

Footnotes:

(1) Method 2340 B (hardness by calculation) from APHA (1992), Standard Methods for the Examination of Water and Wastewater, 18th or subsequent Edition(s).

(2) **Total Residual Chlorine**

Either of the following methods from APHA (1992), Standard Methods for the Examination of Water and Wastewater, 18th or subsequent Edition(s) must be used for these analyses:

- Method 4500-Cl E. Low-Level Amperometric Titration (the preferred method);
- Method 4500-Cl G. DPD Colorimetric Method, or use U.S. EPA Manual of Methods Analysis of Water and Wastes Method 330.5.

VII. TOXICITY TEST DATA ANALYSIS

LC50 Median Lethal Concentration (Determined at 48 Hours)

Methods of Estimation:

- Probit Method
- Spearman-Karber

- Trimmed Spearman-Karber
- Graphical

Reference the flow chart on page 84 or page 172 of EPA 600/4-91/002 for the appropriate method to use on a given data set.

Chronic No Observed Effects Concentration (C-NOEC)

Methods of Estimation:

- Dunnett's Procedure
- Bonferroni's T-Test
- Steel's Many-One Rank Test
- Wilcoxin Rank Sum Test

Reference the flow charts on pages 50, 83, 96, 172, and 176 of EPA 600/4-91/002 for the appropriate method to use on a given data set.

In the case of two tested concentrations causing adverse effects but an intermediate concentration not causing a statistically significant effect, report the C-NOEC as the lowest concentration where there is no observable effect. The definition of NOEC in the EPA Technical Support Document only applies to linear dose-response data.

VIII. TOXICITY TEST REPORTING

A report of results will include the following:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis on chain-of-custody; and
- General description of tests: age of test organisms, origin, dates and results of standard

ATTACHMENT A

toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended. Reference toxicant test data should be included.

- All chemical/physical data generated. (Include minimum detection levels and minimum quantification levels.)

- Raw data and bench sheets.

- Provide a description of dechlorination procedures (as applicable).

- Any other observations or test conditions affecting test outcome.

Appendix C

Test Results for NPDES Variance

eastern analytical

professional laboratory services

Byron Young
US Army Cold Regions Research & Eng. Lab
72 Lyme Road
Hanover, NH 03755

Subject: Laboratory Report

Eastern Analytical, Inc ID:	63291
Client Identification:	pH Adjustment
Date Received:	7/18/2007

Dear Mr. Young:

Enclosed please find the laboratory report for the above identified project All analyses were performed in accordance with our QA/QC Program Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs com for a copy of our NELAP certificate and accredited parameters

The following standard abbreviations and conventions apply to all EAI reports:

Solid samples are reported on a dry weight basis, unless otherwise noted

- < : "less than" followed by the reporting limit
- TNR: Testing Not Requested
- ND: None Detected, no established detection limit
- RL: Reporting Limits
- %R: % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012)

This report package contains the following information: Sample Conditions summary, Analytical Results/Data and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw, Lab Director

Date: 7-26-07

# of pages (excluding cover letter): 4

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 63291

Client: **US Army Cold Regions Research &** Client Designation: **pH Adjustment**

Temperature upon receipt (°C): NA **Received on ice or cold packs (Yes/No): N**

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
63291.01	Effluent	7/18/07	7/18/07	aqueous		Adheres to Sample Acceptance Policy
63291.02	Receiving Water	7/18/07	7/18/07	aqueous		Adheres to Sample Acceptance Policy
63291.03	Adjusted Effluent	7/18/07	7/19/07	aqueous		Adheres to Sample Acceptance Policy
63291.04	1x Dilution Factor	7/18/07	7/19/07	aqueous		Adheres to Sample Acceptance Policy
63291.05	40% Below Dilution	7/18/07	7/19/07	aqueous		Adheres to Sample Acceptance Policy
63291.06	20% Below Dilution	7/18/07	7/19/07	aqueous		Adheres to Sample Acceptance Policy
63291.07	20% Above Dilution	7/18/07	7/19/07	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 63291

Client: **US Army Cold Regions Research** Client Designation: **pH Adjustment**

Sample ID:	Effluent	Receiving Water	Adjusted Effluent	1x Dilution Factor				
Lab Sample ID:	63291.01	63291.02	63291.03	63291.04				
Matrix:	aqueous	aqueous	aqueous	aqueous				
Date Sampled:	7/18/07	7/18/07	7/19/07	7/19/07				
Date Received:	7/18/07	7/18/07	7/18/07	7/18/07	**Units**	**Date of Analysis**	**Method**	**Analyst**
pH	7.9	7.4	9.0	7.5	SU	7/19/07	4500H+B	KJP

Sample ID:	40% Below Dilution	20% Below Dilution	20% Above Dilution				
Lab Smple ID:	63291.05	63291.06	63291.07				
Matrix:	aqueous	aqueous	aqueous				
Date Sampled:	7/19/07	7/19/07	7/19/07				
Date Received:	7/18/07	7/18/07	7/18/07	**Units**	**Date of Analysis**	**Method**	**Analyst**
pH	7.5	7.5	7.5	SU	7/19/07	4500H+B	KJP

Date: 7/19/07	Start Time: 14:05	End Time: 14:55
pH of Receiving Water Grab Sample:		(1) 7.43
pH of Effluent Grab Sample:		(2) 7.92
pH of Effluent Composite Sample:		~~(3)~~ N/A

	Effluent Grab Sample	Effluent Comp. Sample
pH (after pH adjustment):	(4) 9.01	~~(5)~~ N/A

Serial Dilution		Volume of pH Adjusted Effluent (ml)	Volume of Receiving Water (ml)	Resultant pH Data	
				Effluent Grab /Receiving Water Mixture	Effluent Composite /Receiving Water Mixture
D1: 40% below actual design dilution factor	(6) 164	(10) 3.0	(14) 497.0	(18) 7.49	~~(22)~~ N/A
D2: 20% below actual design dilution factor	(7) 219	(11) 2.3	(15) 497.7	(19) 7.47	~~(23)~~ N/A
D3: at actual design dilution factor	(8) 274	(12) 1.8	(16) 498.2	(20) 7.46	~~(24)~~ N/A
D4: 20% above actual design dilution factor	(9) 329	(13) 1.5	(17) 498.5	(21) 7.46	~~(25)~~ N/A

(1): record the pH of a representative upstream receiving water grab sample; for tidal waters also note the salinity
(2): record the pH of a representative effluent grab sample
~~(3)~~: record the pH of a representative effluent composite sample
(4): record the pH of the representative effluent grab sample after pH adjustment (should be either pH 6.0 or 9.0)
~~(5)~~: record the pH of the representative effluent composite sample after pH adjustment (should be either pH 6.0 or 9.0)
(6)-(9): record the four dilutions, and note the volumes used to make up the dilutions (10)-(17): record the resultant pH of each mixture (18)-(25).

Notes/Comments: Measurements performed using Radiometer TIM 845

EA1 Analysts: KJP/JG

Page 1 of 1

CHAIN-OF-CUSTODY RECORD

BOLD FIELDS REQUIRED. PLEASE CIRCLE REQUESTED ANALYSIS.

6329

VOC: NH524.2 Full List 524.2; 524.2 BTEX 524.2 MTBE only; NH8260B Full List 8260B; 8021B VTICs 624; 8021B BTEX Halos; 8015B GRO MEGRO MAVPH
SVOC: 8270C 625 SVTICs; ABN A BN PAH; TPH8100 L1 L2; 8015B DRO MEDRO MAEPH; 608 Pest/PCB; Pest 8081A PCB 8082; Oil & Grease 1664 TPH 1664
TCLP: TCLP 1311 ABN Metals; VOC Pest Herb
Metals: Dissolved Metals (List Below); Total Metals (List Below)
Inorganics: TS TSS TDS Spec Con; Br Cl F SO_4; NO_3 NO_2 NO_2/NO_3; BOD CBOD T. Alk; TKN NH_3 T. Phos; pH T. Res. Chlorine; COD Phenols TOC; Total Cyanide Total Sulfide; Reactive Cyanide Reactive Sulfide; Flashpoint Ignitability
Micro: T. Coliform E. Coli; F. Coliform; Enterococci; Heterotrophic Plate Count
Other

Sample I.D.	Sampling Date/Time *If Composite, Indicate Start Date/Time	Matrix (see below)	Grab/*Composite	pH	# of Containers	Notes MeOH Vial #
Effluent	7/18/07 09:45	WW	G	X		
Receiving water	7/18/07 11:00	SW	G	X	2	
Adjusted Effluent	7/19/07 14:15	WW	G	X	2	
1X Dilution	7/19/07 14:40	SW	G	X	1	
40% Below	7/19/07 14:30	SW	G	X	1	
20% Below	7/19/07 14:35	SW	G	X	1	
20% Above	7/19/07 14:45	SW	G	X	1	

Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste Water
Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

Project Manager: Byron Young
Company: Cold Regions Research + Env. Lab
Address: Lyme Rd
City: Hanover State: NH Zip:
Phone: 646-4602 Ext.:
Fax:
E-Mail:
Site Name: PH Adjustment
Project #:
State: NH MA ME VT Other:
Is your project RGP? Y / N
Quote #: 1005201 PO #:

Date Needed: std

QA/QC Reporting Level: A B C or MA MCP Presumptive Certainty

Reporting Options: Prelims: Yes or No; If Yes: Fax or PDF
Electronic Options: No Fax E-Mail PDF Equis

Temp. ____ °C Ice? Yes No

Sampler(s): J. Gagne, K. Prescott 7/19/07; D. Nevison, I. Forsey 7/18/07

Relinquished By:	Date:	Time:	Received By:
[signature]	7/19/07	1540	[signature]

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu
Other Metals:
Dissolved Metals Field Filtered? Yes No
Notes: (ie: Special Detection Limits, Billing Info, If Different)
NPDES
pH Adjustment study
Report results by filling out form (attached)

eastern analytical, inc. professional laboratory services 25 Chenell Drive | Concord, NH 03301 | Tel: 603.228.0525 | 1.800.287.0525 | Fax: 603.228.4591 | E-Mail: customer_service@eailabs.com | www.eailabs.com

(WHITE: ORIGINAL GREEN: PROJECT MANAGER)

Appendix D

CRREL Well Pumpage Data

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
January 1, 2006	357359000	292000	52456.2	13.7	736107000	0	11144.3	0.0	85102100	32000	90251.8	1.8	100443	1	20401.32	0.0	35462100	237500	5828.93	14.6	561501
January 2, 2006	357695000	336000	52472.0	15.8	736107000	0	11144.3	0.0	85137100	35000	90253.7	1.9	100452	9	20401.32	0.0	35725800	263700	5845.35	16.4	634709
January 3, 2006	357953000	258000	52484.3	12.3	736107000	0	11144.3	0.0	85160400	23300	90255.0	1.3	100472	20	20401.32	0.0	35928600	202800	5857.95	12.6	484120
January 4, 2006	358275000	322000	52499.5	15.2	736107000	0	11144.3	0.0	85171600	11200	90255.6	0.6	102373	1901	20401.49	0.2	36180900	252300	5873.62	15.7	587401
January 5, 2006	358578000	303000	52513.9	14.4	736107000	0	11144.3	0.0	85183100	11500	90256.2	0.6	102422	49	20401.49	0.0	36429500	248600	5889.17	15.6	563149
January 6, 2006	358890000	312000	52528.8	14.9	736107000	0	11144.3	0.0	85239700	56600	90259.3	3.1	105043	2621	20401.75	0.3	36671200	241700	5904.62	15.4	612921
January 7, 2006	359193000	303000	52543.3	14.5	736107000	0	11144.3	0.0	85274400	34700	90261.2	1.9	105154	111	20401.75	0.0	36904900	233700	5919.47	14.9	571511
January 8, 2006	359506000	313000	52558.0	14.7	736107000	0	11144.3	0.0	85315000	40600	90263.4	2.2	105227	73	20401.75	0.0	37151200	246300	5934.78	15.3	599973
January 9, 2006	359800000	294000	52571.9	13.9	736107000	0	11144.3	0.0	85349700	34700	90265.3	1.9	105241	14	20401.75	0.0	37378700	227500	5949.05	14.3	556214
January 10, 2006	360100000	300000	52586.1	14.2	736107000	0	11144.3	0.0	85400000	50300	90268.1	2.8	107391	2150	20401.95	0.2	37611500	232800	5963.61	14.6	585250
January 11, 2006	360441000	341000	52602.0	15.9	736107000	0	11144.3	0.0	85449400	49400	90270.7	2.6	107442	51	20401.95	0.0	37876600	265100	5980.06	16.5	655551
January 12, 2006	360758000	317000	52616.9	14.9	736107000	0	11144.3	0.0	85490700	41300	90272.9	2.2	107454	12	20401.95	0.0	38122600	246000	5995.36	15.3	604312
January 13, 2006	361062000	304000	52631.2	14.3	736107000	0	11144.3	0.0	85525333	34633	90274.8	1.9	107962	508	20401.95	0.0	38359000	236400	6010.10	14.7	575541
January 14, 2006	361366000	304000	52645.5	14.3	736107000	0	11144.3	0.0	85559967	34633	90276.7	1.9	107962	0	20401.95	0.0	38595400	236400	6024.83	14.7	575033
January 15, 2006	361670000	304000	52659.8	14.3	736107000	0	11144.3	0.0	85594600	34633	90278.6	1.9	107962	0	20401.95	0.0	38831800	236400	6039.57	14.7	575033
January 16, 2006	361950000	280000	52673.1	13.3	736107000	0	11144.3	0.0	85623800	29200	90280.2	1.6	107462	0	20401.95	0.0	39046200	214400	6053.22	13.7	523600
January 17, 2006	362261000	311000	52687.8	14.7	736107000	0	11144.3	0.0	85664200	40400	90282.4	2.2	108321	859	20402.02	0.1	39287900	241700	6068.32	15.1	593959
January 18, 2006	362583000	322000	52702.9	15.1	736110000	3000	11144.5	0.2	85699500	35300	90284.3	1.9	109719	1398	20402.14	0.1	39540800	252900	6083.93	15.6	614598
January 19, 2006	362907000	324000	52718.1	15.2	736112000	2000	11144.6	0.1	85718100	18600	90285.4	1.1	110717	998	20402.22	0.1	39795800	255000	6099.70	15.8	600598
January 20, 2006	363183000	276000	52731.1	13.0	736112000	0	11144.6	0.0	85736600	18500	90286.4	1.0	110798	81	20402.22	0.0	40011900	216100	6113.05	13.4	510681
January 21, 2006	363550000	367000	52748.3	17.2	736113000	1000	11144.6	0.0	85759100	22500	90287.6	1.2	114056	3258	20402.55	0.3	40299500	287600	6130.87	17.8	681358
January 22, 2006	363828000	278000	52761.4	13.1	736113000	0	11144.6	0.0	85770350	11250	90288.2	0.6	114056	0	20402.55	0.0	40516200	216700	6144.33	13.5	505950
January 23, 2006	364135000	307000	52775.8	14.4	736113000	0	11144.6	0.0	85781600	11250	90288.8	0.6	114056	0	20402.55	0.0	40755600	239400	6159.14	14.8	557650
January 24, 2006	364447000	312000	52790.6	14.8	736113000	0	11144.6	0.0	85793300	11700	90289.5	0.7	114056	0	20402.55	0.0	40998600	243000	6174.33	15.2	566700
January 25, 2006	364760000	313000	52805.3	14.7	736113000	0	11144.6	0.0	85816100	22800	90290.7	1.2	115146	1090	20402.64	0.1	41242800	244200	6189.47	15.1	581090
January 26, 2006	365074000	314000	52820.2	14.9	736113000	0	11144.6	0.0	85827400	11300	90291.3	0.6	115168	22	20402.64	0.0	41488400	245600	6204.76	15.3	570922
January 27, 2006	365378000	304000	52834.6	14.4	736113000	0	11144.6	0.0	85839100	11700	90292.0	0.7	115168	0	20402.65	0.0	41725500	237100	6219.60	14.8	552800
January 28, 2006	365697000	319000	52849.7	15.1	736113000	0	11144.6	0.0	85850600	11500	90292.6	0.6	115168	0	20402.64	0.0	41982200	256700	6235.48	15.9	587200
January 29, 2006	366002000	305000	52864.1	14.4	736113000	0	11144.6	0.0	85867800	17200	90293.6	0.9	115168	0	20402.64	0.0	42228700	246500	6250.65	15.2	568700
January 30, 2006	366296000	294000	52878.1	14.0	736113000	0	11144.6	0.0	85885000	17200	90294.5	0.9	115168	0	20402.64	0.0	42461000	232300	6265.00	14.4	543500
January 31, 2006	366621000	325000	52893.5	15.4	736113000	0	11144.6	0.0	85890900	5900	90294.8	0.3	115168	0	20402.64	0.0	42717000	256000	6280.87	15.9	586900
Total		9554000		451.0		6000		0.3		820800		44.8		15226		1.3		7492400		466.5	17888426

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
February 1, 2006	366930000	309000	52908.2	14.7	736113000	0	11144.6	0.0	85896500	5600	90295.1	0.3	115168	0	20402.64	0.0	42968200	251200	6296.37	15.5	565800
February 2, 2006	367235000	305000	52922.6	14.4	736113000	0	11144.6	0.0	85919700	23200	90296.3	1.2	115168	0	20402.64	0.0	43216900	248700	6311.63	15.3	576900
February 3, 2006	367548000	313000	52937.5	14.9	736113000	0	11144.6	0.0	85950100	30400	90298.0	1.7	115168	0	20402.64	0.0	43471900	255000	6327.33	15.7	598400
February 4, 2006	367855000	307000	52952.0	14.5	736113000	0	11144.6	0.0	85971800	21700	90299.2	1.2	115180	12	20402.64	0.0	43718300	246400	6342.47	15.1	575112
February 5, 2006	368190000	335000	52968.1	16.1	736113000	0	11144.6	0.0	86000800	29000	90300.7	1.5	115194	14	20402.64	0.0	43989900	271600	6359.19	16.7	635614
February 6, 2006	368496000	306000	52982.1	14.0	736113000	0	11144.6	0.0	86035500	34700	90302.6	1.9	115196	2	20402.64	0.0	44226600	236700	6373.91	14.7	577402
February 7, 2006	368810000	314000	52997.5	15.4	736113000	0	11144.6	0.0	86066900	31400	90304.3	1.7	118631	3435	20403.00	0.4	44474000	247400	6389.47	15.6	596235
February 8, 2006	369095000	285000	53011.0	13.5	736113000	0	11144.6	0.0	86099200	32300	90306.1	1.8	122219	3588	20403.37	0.4	44699700	225700	6403.47	14.0	546588
February 9, 2006	369405000	310000	53025.8	14.8	736113000	0	11144.6	0.0	86134000	34800	90308.0	1.9	122442	223	20403.38	0.0	44960400	260700	6419.46	16.0	605723
February 10, 2006	369717000	312000	53040.9	15.1	736113000	0	11144.6	0.0	86162800	28800	90309.5	1.5	122442	0	20403.38	0.0	45213300	252900	6435.30	15.8	593700
February 11, 2006	370027000	310000	53055.7	14.8	736113000	0	11144.6	0.0	86168700	5900	90309.8	0.3	122445	3	20403.38	0.0	45463600	250300	6450.75	15.4	566203
February 12, 2006	370310000	283000	53069.3	13.6	736113000	0	11144.6	0.0	86168700	0	90309.8	0.0	122445	0	20403.38	0.0	45693500	229900	6464.86	14.1	512900
February 13, 2006	370630000	320000	53084.7	15.4	736113000	0	11144.6	0.0	86168700	0	90309.8	0.0	122445	0	20403.38	0.0	45941800	248300	6480.32	15.5	568300
February 14, 2006	370955000	325000	53100.6	15.9	736113000	0	11144.6	0.0	86174600	5900	90310.3	0.5	124528	2083	20403.58	0.2	46192100	250300	6497.08	16.8	583283
February 15, 2006	371235000	280000	53114.2	13.6	736122000	9000	11145.0	0.4	86186700	12100	90310.8	0.5	130462	5934	20404.20	0.6	46428700	236600	6510.97	13.9	543634
February 16, 2006	371553000	318000	53129.5	15.3	736122000	0	11145.0	0.0	86186700	0	90310.8	0.0	130462	0	20404.20	0.0	46682600	253900	6526.66	15.7	571900
February 17, 2006	371875000	322000	53145.2	15.7	736122000	0	11145.0	0.0	86204300	17600	90311.8	1.0	132742	2280	20404.41	0.2	46940400	257800	6542.89	16.2	599680
February 18, 2006	372197500	322500	53160.6	15.4	736122000	0	11145.0	0.0	86213050	8750	90312.3	0.4	132879	137	20404.41	0.0	47198200	257800	6559.18	16.3	589187
February 19, 2006	372520000	322500	53176.0	15.4	736122000	0	11145.0	0.0	86221800	8750	90312.7	0.4	132879	0	20404.41	0.0	47456000	257800	6575.46	16.3	589050
February 20, 2006	372835000	315000	53192.8	16.8	736122000	0	11145.0	0.0	86239300	17500	90313.7	1.0	135034	2155	20404.63	0.2	47709500	253500	6591.74	16.3	588155
February 21, 2006	373144000	309000	53208.7	15.9	736122000	0	11145.0	0.0	86239300	0	90313.7	0.0	135105	71	20404.63	0.0	47957400	247900	6607.45	15.7	556971
February 22, 2006	373470000	326000	53223.9	15.2	736122000	0	11145.0	0.0	86256400	17100	90314.6	0.9	137390	2285	20404.89	0.3	48222000	264600	6623.77	16.3	609985
February 23, 2006	373774000	304000	53239.1	15.2	736122000	0	11145.0	0.0	86279500	23100	90315.8	1.2	137423	33	20404.89	0.0	48465100	243100	6639.27	15.5	570233
February 24, 2006	374094000	320000	53254.7	15.6	736122000	0	11145.0	0.0	86302800	23300	90317.1	1.3	137423	0	20404.89	0.0	48730400	265300	6655.78	16.5	608600
February 25, 2006	374400000	306000	53269.7	15.0	736122000	0	11145.0	0.0	86320100	17300	90318.1	1.0	137454	31	20404.89	0.0	48976100	245700	6671.12	15.3	569031
February 26, 2006	374696000	296000	53284.3	14.6	736122000	0	11145.0	0.0	86342900	22800	90319.3	1.2	137454	0	20404.89	0.0	49212800	236700	6686.16	15.0	555500
February 27, 2006	375086000	390000	53303.9	19.6	736122000	0	11145.0	0.0	86348800	5900	90319.6	0.3	138422	968	20404.95	0.1	49521500	308700	6706.20	20.0	705568
February 28, 2006	375421000	335000	53320.4	16.5	736325000	203000	11154.6	9.7	86348800	0	90319.6	0.0	138481	59	20404.95	0.0	49635900	114400	6713.38	7.2	652459
Total		8800000		426.9		212000		10.1		457900		24.8		23313		2.3		6918900		432.5	16412113

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
March 1, 2006	375719000	298000	53335.1	14.7	736421000	96000	11159.3	4.6	86360400	11600	90320.2	0.6	138523	42	20404.95	0.0	49808200	172300	6724.15	10.8	577942
March 2, 2006	376122000	403000	53355.1	20.0	736426000	5000	11159.5	0.2	86366200	5800	90320.5	0.3	138894	371	20404.96	0.0	50133400	325200	6745.10	21.0	739371
March 3, 2006	376317000	195000	53364.7	9.6	736668000	242000	11170.7	11.1	86377900	11700	90321.2	0.7	139624	730	20404.96	0.0	50302200	168800	6755.62	10.5	618230
March 4, 2006	376578000	261000	53377.5	12.8	736960000	292000	11183.9	13.3	86385200	7300	90321.6	0.4	139624	0	20404.96	0.0	50308100	5900	6755.95	0.3	566200
March 5, 2006	376851000	273000	53391.0	13.5	737260000	300000	11197.7	13.8	86396500	11300	90322.2	0.6	139624	0	20404.96	0.0	50308100	0	6755.95	0.0	584300
March 6, 2006	377082000	231000	53402.5	11.5	737531000	271000	11210.0	12.3	86396500	0	90322.2	0.0	138692	0	20404.96	0.0	50312000	3900	6756.00	0.1	505900
March 7, 2006	377082000	0	53402.5	0.0	737858000	327000	11224.8	14.8	86408300	11800	90322.8	0.6	138704	12	20404.96	0.0	50548900	236900	6770.90	14.9	575712
March 8, 2006	377082000	0	53402.5	0.0	738205000	347000	11240.3	15.5	86414000	5700	90328.1	5.3	138718	14	20404.96	0.0	50799000	250100	6786.30	15.4	602814
March 9, 2006	377082000	0	53402.5	0.0	738530000	325000	11255.2	14.9	86419900	5900	90323.5	0.0	138729	11	20404.96	0.0	51036400	237400	6801.26	15.0	568311
March 10, 2006	377082000	0	53402.5	0.0	738858000	328000	11269.7	14.5	86443400	23500	90324.7	1.2	138724	0	20404.96	0.0	51278800	242400	6816.20	14.9	593900
March 11, 2006	377082000	0	53402.5	0.0	739212000	354000	11285.7	16.0	86455200	11800	90325.4	0.7	138724	0	20404.96	0.0	51538100	259300	6832.20	16.0	625100
March 12, 2006	377082000	0	53402.5	0.0	739500000	288000	11298.8	13.1	86466700	11500	90326.0	0.6	138724	0	20404.90	0.0	51742300	204200	6845.10	12.9	503700
March 13, 2006	377082000	0	53402.5	0.0	739841000	341000	11314.5	15.7	86490100	23400	90327.3	1.3	138767	43	20404.96	0.1	51989700	247400	6860.97	15.9	611843
March 14, 2006	377082000	0	53402.5	0.0	740166000	325000	11329.2	14.6	86490100	0	90327.3	0.0	138767	0	20404.96	0.0	52229600	239900	6875.92	14.9	564900
March 15, 2006	377082000	0	53402.5	0.0	740486000	320000	11343.3	14.1	86507700	17600	90328.2	0.9	138767	0	20404.96	0.0	52466500	236900	6890.50	14.6	574500
March 16, 2006	377090000	8000	53402.6	0.1	740824000	338000	11358.5	15.2	86531100	23400	90329.5	1.3	142491	3724	20405.31	0.4	52709100	242600	6905.66	15.2	615724
March 17, 2006	377090000	0	53402.6	0.0	741157000	333000	11373.3	14.8	86559900	28800	90331.0	1.5	142491	0	20405.31	0.0	52953000	243900	6920.70	15.0	605700
March 18, 2006	377090000	0	53402.6	0.0	741530000	373000	11389.9	16.6	86565700	5800	90331.3	0.3	142491	0	20405.31	0.0	53224400	271400	6937.50	16.8	650200
March 19, 2006	377090000	0	53402.6	0.0	741806000	276000	11402.4	12.5	86565700	0	90331.3	0.0	142491	0	20405.31	0.0	53424000	199600	6950.10	12.6	475600
March 20, 2006	377090000	0	53402.6	0.0	742167000	361000	11419.1	16.7	86589100	23400	90332.6	1.3	142491	0	20405.31	0.0	53680600	256600	6966.53	16.4	641000
March 21, 2006	377090000	0	53402.6	0.0	742501000	334000	11434.2	15.1	86595200	6100	90332.9	0.3	142491	0	20405.31	0.0	53927600	247000	6982.04	15.5	587100
March 22, 2006	377090000	0	53402.6	0.0	742836000	335000	11449.0	14.8	86601100	5900	90333.3	0.4	142491	0	20405.31	0.0	54170700	243100	6997.11	15.1	584000
March 23, 2006	377090000	0	53402.6	0.0	743171000	335000	11464.1	15.1	86601100	0	90333.3	0.0	142521	30	20405.33	0.0	54412300	241600	7012.27	15.2	576630
March 24, 2006	377090000	0	53402.8	0.2	743506000	335000	11479.0	14.9	86601100	0	90333.3	0.0	142521	0	20405.33	0.0	54656400	244100	7027.46	15.2	579100
March 25, 2006	377090000	0	53402.8	0.0	743823000	317000	11493.0	14.0	86601000	0	90333.3	0.0	142562	41	20405.33	0.0	54889000	232600	7041.87	14.4	549641
March 26, 2006	377090000	0	53402.8	0.0	744315000	492000	11514.9	21.9	86606700	5700	90333.6	0.3	142600	38	20405.33	0.0	55242500	353500	7063.90	22.0	851238
March 27, 2006	377090000	0	53402.8	0.0	744807000	492000	11537.2	22.3	86606700	0	90333.6	0.0	142629	29	20405.33	0.0	55591700	349200	7086.02	22.1	841229
March 28, 2006	377090000	0	53402.8	0.0	745294000	487000	11559.0	21.8	86606700	0	90333.6	0.0	142629	0	20405.32	0.0	55946600	354900	7108.21	22.2	841900
March 29, 2006	377090000	0	53402.8	0.0	745764000	470000	11579.8	20.8	86612500	5800	90333.9	0.3	142629	0	20405.30	0.0	56297800	351200	7130.00	21.8	827000
March 30, 2006	377090000	0	53402.8	0.0	746288000	524000	11603.4	23.6	86612500	0	90333.9	0.0	142629	0	20405.32	0.0	56669800	372000	7153.55	23.6	896000
March 31, 2006	377090000	0	53402.8	0.0	746789000	501000	11626.1	22.7	86612500	0	90333.9	0.0	142629	0	20405.30	0.0	57038700	368900	7177.00	23.4	869900
Total		1669000		82.4		10464000		471.5		263800		18.9		5085		0.5		7402800		463.6	19804685

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
April 1, 2006	377090000	0	53402.8	0.0	747221000	432000	11646.2	20.1	86612500	0	90333.9	0.0	142629	0	20405.32	0.0	57339100	300400	7196.60	19.6	732400
April 2, 2006	377090000	0	53402.8	0.0	747744000	523000	11669.9	23.7	86612500	0	90333.9	0.0	142629	0	20405.32	0.0	57713500	374400	7220.60	24.0	897400
April 3, 2006	377090000	0	53402.8	0.0	748165000	421000	11689.6	19.7	86612500	0	90333.9	0.0	142796	167	20405.32	0.0	58012800	299300	7240.26	19.7	720467
April 4, 2006	377336000	246000	53415.1	12.3	748609000	444000	11710.3	20.7	86612500	0	90333.9	0.0	142796	0	20405.32	0.0	58144000	131200	7248.99	8.7	821200
April 5, 2006	377729000	393000	53434.5	19.4	749040000	431000	11729.9	19.6	86612500	0	90333.9	0.0	142796	0	20405.32	0.0	58144000	0	7248.99	0.0	824000
April 6, 2006	378115000	386000	53453.7	19.2	749470000	430000	11749.6	19.8	86612500	0	90333.9	0.0	142796	0	20405.32	0.0	58144000	0	7248.99	0.0	816000
April 7, 2006	378484000	369000	53472.2	18.5	749895000	425000	11769.2	19.6	86612500	0	90333.9	0.0	142796	0	20405.32	0.0	58144100	100	7248.99	0.0	794100
April 8, 2006	378838000	354000	53490.0	17.8	750291000	396000	11787.0	17.8	86624800	12300	90334.5	0.6	142960	164	20405.32	0.0	58144100	0	7248.99	0.0	762464
April 9, 2006	379230000	392000	53510.1	20.1	750725000	434000	11807.9	20.9	86624800	0	90334.5	0.0	142960	0	20405.32	0.0	58144100	0	7248.99	0.0	826000
April 10, 2006	379610000	380000	53529.4	19.3	751134000	409000	11827.0	19.1	86624800	0	90334.5	0.0	142960	0	20405.32	0.0	58144100	0	7248.99	0.0	789000
April 11, 2006	380036000	426000	53550.0	20.6	751615000	481000	11849.1	22.1	86624800	0	90334.5	0.0	143053	93	20405.32	0.0	58167900	23800	7250.30	1.3	930893
April 12, 2006	380345000	309000	53566.6	16.6	751961000	346000	11865.5	16.4	86624800	0	90337.8	3.3	143081	28	20405.32	0.0	58167900	0	7250.30	0.0	655028
April 13, 2006	380594000	249000	53579.5	12.9	752244000	283000	11879.0	13.5	86685200	60400	90337.8	0.0	143109	28	20405.32	0.0	58167900	0	7250.38	0.1	592428
April 14, 2006	380837000	243000	53591.7	12.2	752520000	276000	11891.6	12.6	86685200	0	90337.8	0.0	143081	0	20405.32	0.0	58167900	0	7250.30	0.0	519000
April 15, 2006	381085000	248000	53604.0	12.3	752802000	282000	11904.2	12.6	86685200	0	90337.8	0.0	143180	99	20405.32	0.0	58188100	20200	7251.59	1.3	550299
April 16, 2006	381312000	227000	53618.3	14.3	753128000	326000	11919.0	14.8	86685200	0	90337.8	0.0	143180	0	20405.32	0.0	58188100	0	7251.59	0.0	553000
April 17, 2006	381588000	276000	53629.1	10.8	753374000	246000	11930.4	11.4	86685200	0	90337.8	0.0	143254	74	20405.32	0.0	58188100	0	7251.59	0.0	522074
April 18, 2006	381932000	344000	53646.0	16.9	753754000	380000	11947.0	16.6	86686000	800	90337.0	0.0	147720	4466	20405.78	0.5	58206700	18600	7252.69	1.1	747866
April 19, 2006	382342000	410000	53666.7	20.7	754214000	460000	11968.6	21.6	86692300	6300	90338.2	1.2	147812	92	20405.78	0.0	58206700	0	7252.69	0.0	876392
April 20, 2006	382665000	323000	53682.8	16.1	754578000	364000	11985.2	16.6	86692300	0	90338.2	0.0	147812	0	20405.78	0.0	58206700	0	7252.69	0.0	687000
April 21, 2006	382886000	221000	53693.9	11.1	754830000	252000	11996.9	11.7	86692300	0	90338.2	0.0	147893	81	20405.78	0.0	58206700	0	7252.69	0.0	473081
April 22, 2006	383194000	308000	53709.3	15.4	755166200	336200	12012.0	15.1	86692300	0	90338.2	0.0	147955	62	20405.78	0.0	58213000	6300	7253.00	0.3	650562
April 23, 2006	383533000	339000	53726.0	16.7	755549000	382800	12029.3	17.3	86692300	0	90338.2	0.0	147955	0	20405.78	0.0	58213000	0	7253.00	0.0	721800
April 24, 2006	383690000	157000	53733.8	7.8	755857000	308000	12043.3	14.0	86692300	0	90338.2	0.0	148119	164	20405.78	0.0	58302100	89100	7258.65	5.6	554264
April 25, 2006	383690000	0	53733.8	0.0	756185000	328000	12057.8	14.5	86692300	0	90338.2	0.0	148168	49	20405.78	0.0	58551100	249000	7274.10	15.5	577049
April 26, 2006	383690000	0	53733.8	0.0	756559000	374000	12074.4	16.6	86692300	0	90338.2	0.0	148392	224	20405.78	0.0	58815400	264300	7290.40	16.3	638524
April 27, 2006	383690000	0	53733.8	0.0	756930000	371000	12090.9	16.5	86692300	0	90338.2	0.0	148392	0	20405.78	0.0	59078600	263200	7306.80	16.4	634200
April 28, 2006	383690000	0	53733.8	0.0	757444000	514000	12113.9	23.0	86692300	0	90338.2	0.0	148392	0	20405.78	0.0	59448200	369600	7329.87	23.1	883600
April 29, 2006	384081000	391000	53753.4	19.6	757883000	439000	12133.9	20.0	86698400	6100	90338.5	0.3	148430	38	20405.78	0.0	59473100	24900	7331.30	1.4	861038
April 30, 2006	384460000	379000	53772.5	19.1	758309000	426000	12153.6	19.7	86698400	0	90338.5	0.0	148487	57	20405.78	0.0	59473100	0	7331.30	0.0	805057
Total		7370000		369.7		11520000		527.5		85900		5.4		5886		0.5		2434400		154.4	21416186

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
May 1, 2006	384930000	470000	53796.5	24.0	758840000	531000	12178.5	24.9	86698400	0	90338.5	0.0	148569	82	20405.70	0.0	59473100	0	7331.35	0.1	1001082
May 2, 2006	385270000	340000	53813.7	17.2	759229000	389000	12196.5	18.0	86698400	0	90338.5	0.0	148648	79	20405.78	0.1	59473100	0	7331.35	0.0	729079
May 3, 2006	385510000	240000	53825.0	11.3	759507000	278000	12209.1	12.6	86698400	0	90338.5	0.0	148713	65	20405.78	0.0	59480400	7300	7331.84	0.5	525365
May 4, 2006	385813000	303000	53840.3	15.3	759853000	346000	12224.7	15.6	86698400	0	90338.5	0.0	148767	54	20405.78	0.0	59480400	0	7331.84	0.0	649054
May 5, 2006	386039000	226000	53851.9	11.6	760112000	259000	12236.5	11.8	86698400	0	90338.5	0.0	148767	0	20405.78	0.0	59480400	0	7331.84	0.0	485000
May 6, 2006	386320000	281000	53865.9	14.0	760430000	318000	12250.9	14.4	86760800	62400	90341.9	3.4	148901	134	20405.78	0.0	59492300	11900	7332.50	0.7	673434
May 7, 2006	386653000	333000	53882.0	16.1	760807000	377000	12268.1	17.2	86895700	134900	90349.2	7.3	148962	61	20405.78	0.0	59492300	0	7332.50	0.0	844961
May 8, 2006	386916000	263000	53895.9	13.9	761101000	294000	12281.9	13.8	86926600	30900	90350.9	1.7	149048	86	20405.78	0.0	59500200	7900	7332.98	0.5	595886
May 9, 2006	387164000	248000	53908.4	12.5	761385000	284000	12294.8	12.9	86951200	24600	90352.2	1.3	149101	53	20405.78	0.0	59500200	0	7332.98	0.0	556653
May 10, 2006	387411000	247000	53920.7	12.3	761662000	277000	12307.3	12.5	86984100	32900	90354.0	1.8	149157	56	20405.78	0.0	59512800	12600	7333.72	0.7	569556
May 11, 2006	387698000	287000	53934.1	13.4	761981000	319000	12322.3	15.0	86984100	0	90354.0	0.0	149157	0	20405.78	0.0	59512800	0	7333.72	0.0	606000
May 12, 2006	387965000	267000	53948.2	14.1	762289000	308000	12336.0	13.7	87014200	30100	90355.6	1.6	149157	0	20405.78	0.0	59512800	0	7333.72	0.0	605100
May 13, 2006	388275000	310000	53963.5	15.3	762621000	332000	12350.9	14.9	87020000	5800	90356.0	0.4	150187	1030	20405.78	0.0	59523800	11000	7334.31	0.6	659830
May 14, 2006	388562000	287000	53977.8	14.3	762954000	333000	12366.1	15.2	87031300	11300	90356.6	0.6	150221	34	20405.78	0.0	59523800	0	7334.31	0.0	631334
May 15, 2006	388891000	329000	53994.3	16.5	763333000	379000	12383.7	17.6	87037700	6400	90356.9	0.3	150221	0	20405.78	0.0	59523800	0	7334.31	0.0	714400
May 16, 2006	389202000	311000	54009.9	15.6	763685000	352000	12399.8	16.1	87037700	0	90356.9	0.0	150221	0	20405.78	0.0	59534800	11000	7335.00	0.7	674000
May 17, 2006	389597000	395000	54029.5	19.6	764124000	439000	12419.7	19.9	87049300	11600	90357.5	0.6	150365	144	20405.78	0.0	59544900	10100	7335.59	0.6	855844
May 18, 2006	389917000	320000	54045.6	16.1	764484000	360000	12436.3	16.5	87061000	11700	90358.2	0.7	150433	68	20405.88	0.1	59544900	0	7335.59	0.0	691768
May 19, 2006	390204000	287000	54060.1	14.5	764810000	326000	12451.1	14.9	87067400	6400	90358.5	0.3	150433	0	20405.88	0.0	59544900	0	7335.59	0.0	619400
May 20, 2006	390522000	318000	54076.7	16.6	765179000	369000	12467.8	16.7	87073200	5800	90358.8	0.3	154417	3984	20406.28	0.4	59558600	13700	7336.40	0.8	710484
May 21, 2006	390865000	343000	54093.8	17.1	765579000	400000	12486.1	18.3	87079100	5900	90359.1	0.3	154417	0	20406.28	0.0	59558600	0	7336.40	0.0	748900
May 22, 2006	391136000	271000	54107.8	14.0	765891000	312000	12500.6	14.5	87079100	0	90358.2	0.0	154417	0	20406.28	0.0	59558600	0	7336.40	0.0	583000
May 23, 2006	391419000	283000	54122.3	14.5	766213000	322000	12515.3	14.7	87096600	17500	90360.1	1.9	154507	90	20406.28	0.0	59564900	6300	7336.78	0.4	628890
May 24, 2006	391744000	325000	54137.9	15.6	766590000	377000	12531.5	16.2	87096600	0	90360.1	0.0	154507	0	20406.28	0.0	59564900	0	7336.78	0.0	702000
May 25, 2006	392025000	281000	54153.1	15.2	766913000	323000	12547.2	15.7	87108300	11700	90360.7	0.6	154507	0	20406.28	0.0	59564900	0	7336.78	0.0	615700
May 26, 2006	392345000	320000	54168.8	15.7	767290000	377000	12563.6	16.4	87282400	174100	90367.3	6.6	154615	108	20406.28	0.0	59564900	0	7336.78	0.0	871208
May 27, 2006	392627000	282000	54183.7	14.9	767613000	323000	12578.9	15.3	87438700	156300	90378.7	11.4	154646	31	20406.28	0.0	59570300	5400	7337.08	0.3	766731
May 28, 2006	392916000	289000	54198.5	14.8	767947000	334000	12594.1	15.2	87622700	184000	90388.6	9.9	154680	34	20406.28	0.0	59570300	0	7337.08	0.0	807034
May 29, 2006	393189000	273000	54212.0	13.5	768259000	312000	12608.5	14.4	87795100	172400	90398.0	9.4	154704	24	20406.28	0.0	59570300	0	7337.08	0.0	757424
May 30, 2006	393584000	395000	54232.8	20.8	768707000	448000	12628.9	20.4	88041900	246800	90411.4	13.4	154737	33	20406.28	0.0	59570300	0	7337.08	0.0	1089833
May 31, 2006	393881000	297000	54248.0	15.2	769055000	348000	12644.8	15.9	88277300	235400	90424.2	12.8	154737	0	20406.28	0.0	59570300	0	7337.08	0.0	880400
Total		9421000		475.5		10746000		491.2		1578900		86.6		6250		0.6		97200		5.8	21849350

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
June 1, 2006	394181000	300000	54263.4	15.4	769414000	359000	12661.1	16.3	88513000	235700	90437.1	12.9	154791	54	20406.28	0.0	59570300	0	7337.08	0.0	894754
June 2, 2006	394486000	305000	54279.1	15.7	769767000	353000	12677.3	16.2	88709200	196200	90447.7	10.6	154810	19	20406.28	0.0	59570300	0	7337.08	0.0	854219
June 3, 2006	394794000	308000	54294.0	14.9	770121000	354000	12693.3	16.0	88837300	128100	90454.7	7.0	154840	30	20406.28	0.0	59576600	6300	7337.40	0.3	796430
June 4, 2006	395081000	287000	54309.6	15.6	770459000	338000	12708.8	15.5	88867300	30000	90456.3	1.6	154840	0	20406.28	0.0	59576600	0	7337.40	0.0	655000
June 5, 2006	395424000	343000	54327.3	17.7	770849000	390000	12726.9	18.1	88995700	128400	90463.3	7.0	154889	49	20406.28	0.0	59576600	0	7337.46	0.1	861449
June 6, 2006	395736000	312000	54343.3	16.0	771209000	360000	12743.2	16.3	89198700	203000	90474.3	11.0	154910	21	20406.20	0.0	59582300	5700	7337.75	0.3	880721
June 7, 2006	395992000	256000	54356.4	13.1	771548100	339100	12758.8	15.6	89402900	204200	90485.1	10.8	154946	36	20406.20	0.0	59582300	0	7337.75	0.0	799336
June 8, 2006	396345000	353000	54373.5	17.1	771930000	381900	12775.8	17.0	89658100	255200	90499.3	14.2	154984	38	20406.20	0.0	59582300	0	7337.75	0.0	990138
June 9, 2006	396673000	328000	54391.3	17.8	772312000	382000	12793.0	17.2	89913900	255800	90513.2	13.9	154984	0	20406.70	0.5	59582300	0	7337.75	0.0	965800
June 10, 2006	396918000	245000	54403.0	11.7	772601000	289000	12805.0	12.0	89925000	11100	90513.8	0.6	155054	70	20406.20	0.0	59587000	4700	7338.07	0.3	549870
June 11, 2006	397244000	326000	54420.7	17.7	772986000	385000	12823.5	18.5	89925000	0	90513.8	0.0	155106	52	20406.20	0.0	59587000	0	7338.07	0.0	711052
June 12, 2006	397520000	276000	54435.1	14.4	773305000	319000	12838.2	14.7	89925000	0	90513.8	0.0	155106	0	20406.20	0.0	59587000	0	7338.07	0.0	595000
June 13, 2006	397750000	230000	54447.7	12.6	773605000	300000	12851.8	13.6	89925000	0	90513.8	0.0	155126	20	20406.28	0.1	59587000	0	7338.07	0.0	530020
June 14, 2006	398063000	313000	54463.2	15.5	773943000	338000	12867.1	15.3	89925000	0	90513.8	0.0	155166	40	20406.28	0.0	59587000	0	7338.07	0.0	651040
June 15, 2006	398319000	256000	54476.4	13.2	774244000	301000	12880.8	13.6	90103000	178000	90523.4	9.6	155198	32	20406.28	0.0	59587000	0	7338.07	0.0	735032
June 16, 2006	398609000	290000	54491.5	15.1	774594000	350000	12896.8	16.0	90410000	307000	90540.2	16.8	156637	1439	20406.42	0.1	59589000	2000	7338.24	0.2	950439
June 17, 2006	398915000	306000	54507.4	15.9	774957000	363000	12913.2	16.4	90650700	240700	90553.2	13.0	156707	70	20406.42	0.0	59589800	800	7338.24	0.0	910570
June 18, 2006	399280000	365000	54526.1	18.7	775377000	420000	12932.2	19.0	90830300	179600	90563.0	9.8	156791	84	20406.42	0.0	59589800	0	7338.24	0.0	964684
June 19, 2006	399607000	327000	54543.1	17.0	775753000	376000	12949.5	17.2	90916000	85700	90567.7	4.7	156813	22	20406.42	0.0	59589800	0	7338.24	0.0	788722
June 20, 2006	399960000	353000	54561.2	18.1	776165000	412000	12968.1	18.6	91068000	152000	90575.9	8.2	156848	35	20406.42	0.0	59589800	0	7338.24	0.0	917035
June 21, 2006	400352000	392000	54581.4	20.2	776618000	453000	12988.5	20.5	91258500	190500	90586.2	10.3	157990	1142	20406.53	0.1	59589800	0	7338.24	0.0	1036642
June 22, 2006	400717000	365000	54600.2	18.8	777037000	419000	13007.6	19.1	91411100	152600	90594.5	8.3	158061	71	20406.53	0.0	59589800	0	7338.24	0.0	936671
June 23, 2006	401027000	310000	54616.1	15.9	777402000	365000	13024.2	16.6	91550100	139000	90602.0	7.5	158188	127	20406.53	0.0	59589800	0	7338.24	0.0	814127
June 24, 2006	401402000	375000	54635.3	19.2	777835000	433000	13043.8	19.6	91703000	152900	90610.3	8.3	158233	45	20406.53	0.0	59589800	0	7338.24	0.0	960945
June 25, 2006	401756000	354000	54653.6	18.3	778241000	406000	13062.5	18.7	91844500	141500	90617.9	7.6	158293	60	20406.54	0.0	59589800	0	7338.24	0.0	901560
June 26, 2006	402141000	385000	54673.8	20.2	778642000	401000	13081.1	18.6	91971500	127000	90624.8	6.9	172890	14597	20408.22	1.7	59615500	25700	7339.96	1.7	953297
June 27, 2006	402418000	277000	54688.1	14.3	778964000	322000	13095.8	14.7	92050400	78900	90629.1	4.3	172932	42	20408.22	0.0	59615500	0	7339.96	0.0	677942
June 28, 2006	402784000	366000	54706.7	18.6	779389000	425000	13115.0	19.2	92276100	225700	90641.3	12.2	174002	1070	20408.32	0.1	59615500	0	7339.96	0.0	1017770
June 29, 2006	403092000	308000	54722.6	15.9	779744000	355000	13131.1	16.1	92512200	236100	90654.1	12.8	174049	47	20408.32	0.0	59615500	0	7339.96	0.0	899147
June 30, 2006	403496000	404000	54743.7	21.1	780206000	462000	13152.5	21.4	92782500	270300	90668.7	14.6	174074	25	20408.32	0.0	59615500	0	7339.96	0.0	1136325
Total		9615000		495.7		#######		507.7		4505200		244.5		19337		2.6		45200		2.9	25335737

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
July 1, 2006	403903000	407000	54765.2	21.5	780664000	458000	13174.0	21.5	93074900	292400	90684.6	15.9	179719	5645	20408.94	0.6	59624400	8900	7340.58	0.6	1171945
July 2, 2006	404264000	361000	54783.5	18.3	781073000	409000	13192.9	18.9	93345500	270600	90699.2	14.6	179945	226	20408.96	0.0	59624400	0	7340.56	0.0	1040826
July 3, 2006	404697000	433000	54801.0	17.5	781460000	387000	13210.5	17.6	93601800	256300	90713.3	14.1	179968	23	20408.96	0.0	59624400	0	7340.56	0.0	1076323
July 4, 2006	404916000	219000	54817.8	16.8	781561000	101000	13215.1	4.6	93890700	288900	90728.8	15.5	290723	110755	20421.21	12.3	59811400	187000	7352.84	12.3	906655
July 5, 2006	405244000	328000	54834.8	17.0	781919000	358000	13231.5	16.4	94162200	271500	90743.5	14.7	295272	4549	20421.70	0.5	59818900	7500	7353.33	0.5	969549
July 6, 2006	405529000	285000	54849.4	14.6	782253000	334000	13246.6	15.1	94415000	252800	90757.3	13.8	295304	32	20421.70	0.0	59818900	0	7353.33	0.0	871832
July 7, 2006	405882000	353000	54867.7	18.3	782660000	407000	13265.4	18.8	94698000	283000	90772.6	15.3	295329	25	20421.70	0.0	59818900	0	7353.33	0.0	1043025
July 8, 2006	406249000	367000	54886.6	18.9	783077000	417000	13284.4	19.0	95012300	314300	90789.6	17.0	295533	204	20421.72	0.0	59819100	200	7353.34	0.0	1098704
July 9, 2006	406558000	309000	54902.4	15.8	783434000	357000	13300.6	16.2	95253600	241300	90802.8	13.2	295562	29	20421.72	0.0	59819100	0	7353.34	0.0	907329
July 10, 2006	406926000	368000	54921.3	18.9	783857000	423000	13319.8	19.3	95568800	315200	90819.9	17.1	295593	31	20421.72	0.0	59819100	0	7353.34	0.0	1106231
July 11, 2006	407173000	247000	54933.9	12.6	784141000	284000	13332.6	12.8	95809000	240200	90833.0	13.1	295615	22	20421.72	0.0	59819100	0	7353.34	0.0	771222
July 12, 2006	407516000	343000	54951.3	17.4	784545000	404000	13350.8	18.1	96164400	355400	90852.3	19.3	296618	1003	20421.80	0.1	59819900	800	7353.39	0.1	1104203
July 13, 2006	407815000	299000	54966.5	15.2	784891000	346000	13366.2	15.4	96361000	196600	90863.0	10.7	296640	22	20421.80	0.0	59819900	0	7353.39	0.0	841622
July 14, 2006	408133000	318000	54984.7	18.2	785273000	382000	13384.0	17.8	96623000	262000	90878.3	15.3	311146	14506	20423.41	1.6	59845000	25100	7355.05	1.7	1001606
July 15, 2006	408460000	327000	55004.4	19.7	785661000	388000	13402.9	18.9	96920200	297200	90896.6	18.3	314174	3028	20423.73	0.3	59845200	200	7355.04	0.0	1015428
July 16, 2006	408768000	308000	55021.9	17.5	786031000	370000	13420.8	17.9	97198900	278700	90913.8	17.2	314228	54	20423.73	0.0	59845200	0	7355.06	0.0	956754
July 17, 2006	409092000	324000	55041.0	19.1	786419000	388000	13439.8	19.0	97454900	256000	90929.7	15.9	314252	24	20423.73	0.0	59845200	0	7355.08	0.0	968024
July 18, 2006	409372000	280000	55057.5	16.5	786760000	341000	13456.4	16.6	97648000	193100	90941.7	12.0	324247	9995	20424.84	1.1	59859500	14300	7355.96	0.9	838395
July 19, 2006	409707000	335000	55077.1	19.6	787184000	424000	13477.0	20.6	97952600	304600	90960.6	18.9	324666	419	20424.87	0.0	59859500	0	7355.96	0.0	1064019
July 20, 2006	410040000	333000	55096.8	19.7	787578000	394000	13496.3	19.3	98212400	259800	90976.9	16.3	324683	17	20424.87	0.0	59859500	0	7355.96	0.0	986817
July 21, 2006	410406000	366000	55118.7	21.9	788049000	471000	13519.7	23.4	98520500	308100	90996.1	19.2	324686	3	20424.87	0.0	59859500	0	7355.96	0.0	1145103
July 22, 2006	410693000	287000	55135.7	17.0	788400000	351000	13537.0	17.3	98864100	343600	91017.5	21.4	325076	390	20424.90	0.0	59859500	0	7355.98	0.0	981990
July 23, 2006	411032000	339000	55155.8	20.1	788819000	419000	13557.6	20.6	99249700	385600	91041.4	23.9	325096	20	20424.90	0.0	59859500	0	7355.98	0.0	1143620
July 24, 2006	411356000	324000	55175.4	19.6	789202000	383000	13576.7	19.1	99625700	376000	91064.9	23.5	330154	5058	20425.47	0.6	59867400	7900	7356.55	0.6	1095958
July 25, 2006	411598000	242000	55190.1	14.7	789492000	290000	13591.1	14.3	99917000	291300	91083.2	18.3	330187	33	20425.47	0.0	59872000	4600	7356.86	0.3	827933
July 26, 2006	411894000	296000	55207.9	17.8	789865000	373000	13609.3	18.2	316000	399000	91108.2	25.0	333071	2884	20425.76	0.3	59872000	0	7356.86	0.0	1070884
July 27, 2006	412254000	360000	55229.7	21.8	790317000	452000	13631.6	22.4	531000	215000	91121.8	13.6	333109	38	20425.76	0.0	59872000	0	7356.86	0.0	1027038
July 28, 2006	412559000	305000	55248.5	18.8	790694000	377000	13650.6	19.0	579000	48000	91124.8	3.0	333130	21	20425.76	0.0	59872000	0	7356.86	0.0	730021
July 29, 2006	412880000	321000	55267.0	18.5	791103000	409000	13670.8	20.2	757800	178800	91136.1	11.3	333607	477	20425.80	0.0	59877700	5700	7357.23	0.4	914977
July 30, 2006	413214000	334000	55288.0	21.0	791516000	413000	13690.9	20.1	918900	161100	91163.4	27.3	337524	3917	20426.22	0.4	59877700	0	7357.23	0.0	912017
July 31, 2006	413465000	251000	55303.3	15.3	791837000	321000	13708.8	17.9	1545200	626300	91186.0	22.6	337814	290	20428.24	2.0	59877700	0	7357.23	0.0	1198590
Total		9969000		559.6		11631000		556.3		8762700		517.3		163740		19.9		262200		17.3	30788640

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
August 1, 2006	413731000	266000	55319.5	16.2	792164000	327000	13722.9	14.0	1637000	91800	91191.8	5.8	337834	20	20426.24	0.0	59877700	0	7357.23	0.0	684820
August 2, 2006	414067000	336000	55339.7	20.2	792598000	434000	13743.9	21.0	1752800	115800	91199.2	7.4	339172	1338	20426.37	0.1	59877700	0	7357.23	0.0	887138
August 3, 2006	414355000	288000	55357.3	17.6	792962000	364000	13761.7	17.8	1878000	125200	91207.2	8.0	339182	10	20426.37	0.0	59877700	0	7357.23	0.0	777210
August 4, 2006	414651000	296000	55375.6	18.3	793311000	349000	13779.0	17.3	2024000	146000	91216.5	9.3	339231	49	20426.37	0.0	59877700	0	7357.23	0.0	791049
August 5, 2006	415059000	408000	55400.5	24.9	793796000	485000	13802.7	23.7	2284400	260400	91233.2	16.7	341708	2477	20426.64	0.3	59877700	0	7357.23	0.0	1155877
August 6, 2006	415325000	266000	55416.7	16.2	794141000	345000	13819.4	16.7	2594200	309800	91253.1	19.9	341733	25	20426.64	0.0	59877700	0	7357.23	0.0	920825
August 7, 2006	415659000	334000	55437.1	20.4	794554000	413000	13839.7	20.3	2961900	367700	91276.8	23.7	341757	24	20426.64	0.0	59877700	0	7357.26	0.0	1114724
August 8, 2006	415918000	259000	55453.1	16.0	794885000	331000	13855.9	16.3	3271000	309100	91297.0	20.2	341772	15	20426.64	0.0	59877700	0	7357.26	0.0	899115
August 9, 2006	416237000	319000	55472.7	19.6	795297000	412000	13878.0	22.1	3624800	353800	91319.0	22.0	344661	2889	20426.95	0.3	59877700	0	7357.26	0.0	1087689
August 10, 2006	416540000	303000	55491.6	18.9	795682000	385000	13895.1	17.1	3834000	209200	91333.5	14.5	344695	34	20426.95	0.0	59877700	0	7357.26	0.0	897234
August 11, 2006	416854000	314000	55511.6	20.0	796092000	410000	13915.8	20.7	4035000	201000	91346.6	13.1	344722	27	20426.95	0.0	59880600	2900	7357.45	0.2	927927
August 12, 2006	417126000	272000	55528.5	16.9	796442000	350000	13933.2	17.4	4205600	170600	91357.7	11.1	356828	12106	20428.56	1.6	59880600	0	7357.45	0.0	804706
August 13, 2006	417446000	320000	55548.3	19.8	796858000	416000	13953.4	20.2	4379000	173400	91368.9	11.2	360310	3482	20428.95	0.4	59880600	0	7357.45	0.0	912882
August 14, 2006	417748000	302000	55567.2	18.9	797251000	393000	13972.7	19.3	4514000	135000	91377.7	8.8	360355	45	20428.95	0.0	59880600	0	7357.45	0.0	830045
August 15, 2006	417991000	243000	55582.3	15.1	797571000	320000	13988.2	15.5	4677100	163100	91388.3	10.6	360371	16	20428.95	0.0	59880600	0	7357.45	0.0	726116
August 16, 2006	418302000	311000	55601.8	19.5	797979000	408000	14007.9	19.7	4898200	221100	91402.7	14.4	367825	7454	20429.77	0.8	59887500	6900	7357.88	0.4	954454
August 17, 2006	418522000	220000	55619.4	17.6	798349000	370000	14026.0	18.1	5091000	192800	91415.4	12.7	367867	42	20429.77	0.0	59887500	0	7357.88	0.0	782842
August 18, 2006	418861000	339000	55637.3	17.9	798714000	365000	14044.1	18.1	5267000	176000	91427.0	11.6	367891	24	20429.77	0.0	59887500	0	7357.88	0.0	880024
August 19, 2006	419203000	342000	55658.9	21.6	799160000	446000	14065.9	21.9	5482200	215200	91441.0	14.0	371944	4053	20430.22	0.5	59887500	0	7357.88	0.0	1007253
August 20, 2006	419435000	232000	55673.6	14.7	799479000	319000	14081.3	15.4	5635400	153200	91451.1	10.1	371985	41	20430.22	0.0	59887500	0	7357.88	0.0	704241
August 21, 2006	419565000	130000	55681.9	8.3	799830000	351000	14098.5	17.2	5818000	182600	91463.1	12.0	372023	38	20430.22	0.0	60017000	129500	7366.76	8.9	793138
August 22, 2006	419565000	0	55681.9	0.0	800186000	356000	14115.8	17.3	5983000	165000	91473.9	10.8	375701	3678	20430.62	0.4	60273000	256000	7384.25	17.5	780678
August 23, 2006	419565000	0	55681.9	0.0	800578000	392000	14134.8	19.0	6167400	184400	91486.0	12.1	378879	3178	20430.97	0.4	60554100	281100	7403.22	19.0	860678
August 24, 2006	419718000	153000	55691.6	9.7	801002000	424000	14155.6	20.7	6326000	158600	91496.5	10.5	378894	15	20430.97	0.0	60712000	157900	7413.98	10.8	893515
August 25, 2006	419718000	0	55691.6	0.0	801539000	537000	14182.3	26.8	6531200	205200	91510.1	13.6	378898	4	20430.97	0.0	61095400	383400	7440.61	26.6	1125604
August 26, 2006	419718000	0	55691.6	0.0	801944000	405000	14202.6	20.3	6716500	185300	91522.3	12.2	378983	85	20430.97	0.0	61391000	295600	7461.20	20.6	885985
August 27, 2006	419718000	0	55691.6	0.0	802254000	310000	14217.9	15.3	6876500	160000	91534.5	12.2	379009	26	20430.97	0.0	61618800	227800	7476.77	15.6	697826
August 28, 2006	419718000	0	55691.6	0.0	802645000	391000	14236.8	18.9	6952700	76200	91538.0	3.5	379034	25	20430.97	0.0	61901800	283000	7495.86	19.1	750225
August 29, 2006	419718000	0	55691.6	0.0	803045000	400000	14256.4	19.6	7097300	144600	91547.6	9.6	379045	11	20430.97	0.0	62201000	299200	7516.15	20.3	843811
August 30, 2006	419718000	0	55691.6	0.0	803376000	331000	14272.7	16.3	7222000	124700	91555.9	8.3	379052	7	20430.97	0.0	62442000	241000	7532.55	16.4	696707
August 31, 2006	419718000	0	55691.6	0.0	803862000	486000	14296.6	23.9	7388000	166000	91566.9	11.0	382802	3750	20431.39	0.4	62790000	348000	7556.26	23.7	1003750
Total		6253000		388.3		12025000		587.8		5842800		380.9		44988		5.1		2912300		199.0	27078088

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
September 1, 2006	419718000	0	55691.6	0.0	804307000	445000	14318.7	22.1	7446500	58500	91570.7	3.8	382812	10	20431.39	0.0	63108000	318000	7578.21	21.9	821510
September 2, 2006	420042000	324000	55712.5	20.9	804786000	479000	14342.5	23.8	7446500	0	91570.7	0.0	387777	4965	20431.99	0.6	63153000	45000	7581.26	3.1	852965
September 3, 2006	420288000	246000	55728.2	15.7	805115000	329000	14358.6	16.2	7446500	0	91570.7	0.0	387816	39	20431.99	0.0	63153000	0	7581.26	0.0	575039
September 4, 2006	420559300	271300	55745.8	17.6	805476000	361000	14376.6	18.0	7446500	0	91570.7	0.0	387857	41	20431.99	0.0	63153000	0	7581.26	0.0	632341
September 5, 2006	420769000	209700	55759.4	13.6	805748000	272000	14390.5	13.9	7446500	0	91570.7	0.0	387879	22	20431.99	0.0	63153000	0	7581.26	0.0	481722
September 6, 2006	420974000	205000	55772.6	13.2	806019000	271000	14404.0	13.5	7446500	0	91570.7	0.0	387897	18	20431.95	0.0	63153000	0	7581.26	0.0	476018
September 7, 2006	421235000	261000	55789.0	16.4	806368000	349000	14421.1	17.0	7516000	69500	91575.4	4.7	390948	3051	20432.29	0.3	63153000	0	7581.26	0.0	682551
September 8, 2006	421473000	238000	55804.0	15.0	806678000	310000	14436.2	15.1	7666000	150000	91585.4	10.0	390999	51	20432.29	0.0	63153000	0	7581.28	0.0	698051
September 9, 2006	421737000	264000	55820.7	16.7	807020000	342000	14453.0	16.8	7844500	178500	91597.1	11.7	391044	45	20432.29	0.0	63153000	0	7581.26	0.0	784545
September 10, 2006	421884000	147000	55829.9	9.2	807365000	345000	14469.7	16.7	8001100	156600	91607.5	10.4	391074	30	20432.29	0.0	63259500	106500	7588.97	7.7	755130
September 11, 2006	421884000	0	55829.9	0.0	807647000	282000	14483.2	13.5	8139000	137900	91616.7	9.2	391096	22	20432.29	0.0	63459000	199500	7601.98	13.0	619422
September 12, 2006	421884000	0	55829.9	0.0	808006000	359000	14500.9	17.7	8196700	57700	91620.5	3.8	396838	5742	20432.94	0.6	63733100	274100	7620.40	18.4	696542
September 13, 2006	421884000	0	55829.8	0.0	808302000	296000	14515.2	14.3	8243000	46300	91623.6	3.1	396853	15	20432.94	0.0	63938000	204900	7634.18	13.8	547215
September 14, 2006	421888000	4000	55830.1	0.3	808636000	334000	14531.5	16.3	8339900	96900	91630.0	6.4	398338	1485	20433.09	0.2	64180900	242900	7650.59	16.4	679285
September 15, 2006	421888000	0	55830.1	0.0	808945000	309000	14546.8	15.3	8494000	154100	91640.1	10.1	398385	47	20433.09	0.0	64406600	225700	7665.98	15.4	688847
September 16, 2006	421888000	0	55830.1	0.0	809229000	284000	14560.6	13.8	8556700	62700	91644.3	4.2	398420	35	20433.09	0.0	64628000	221400	7680.85	14.9	568135
September 17, 2006	421888000	0	55830.1	0.0	809541000	312000	14575.7	15.1	8602800	46100	91647.3	3.0	398467	47	20433.09	0.0	64866400	238400	7696.75	15.9	596547
September 18, 2006	421888000	0	55830.1	0.0	809868000	327000	14591.6	15.9	8649100	46300	91650.4	3.1	398496	29	20433.09	0.0	65100200	233800	7712.51	15.8	607129
September 19, 2006	421888000	0	55830.1	0.0	810152000	284000	14605.5	13.9	8695800	46700	91653.5	3.1	398515	19	20433.09	0.0	65306500	206300	7726.47	14.0	537019
September 20, 2006	421888000	0	55830.1	0.0	810456000	304000	14620.3	14.8	8875700	179900	91665.3	11.8	398515	0	20433.09	0.0	65527200	220700	7741.33	14.9	704600
September 21, 2006	421888000	0	55830.1	0.0	810821000	365000	14637.1	16.8	9076800	201100	91676.0	10.7	398555	40	20433.09	0.0	65795300	268100	7759.63	18.3	834240
September 22, 2006	421888000	0	55830.1	0.0	811215000	394000	14657.1	20.0	9281600	204800	91692.4	16.4	398555	0	20433.09	0.0	66064500	269200	7777.50	17.9	868000
September 23, 2006	421888000	0	55830.1	0.0	811476000	261000	14669.8	12.7	9419800	138200	91701.6	9.2	398555	0	20433.09	0.0	66266700	202200	7791.22	13.7	601400
September 24, 2006	421888000	0	55830.1	0.0	811714000	238000	14681.3	11.5	9498500	78700	91706.8	5.2	398555	0	20433.09	0.0	66446600	179900	7803.30	12.1	496600
September 25, 2006	421888000	0	55830.1	0.0	811903000	189000	14690.4	9.1	9570100	71600	91711.5	4.7	398605	50	20433.09	0.0	66579400	132800	7812.23	8.9	393450
September 26, 2006	421888000	0	55830.1	0.0	812148000	245000	14702.2	11.8	9713800	143700	91721.0	9.5	398615	10	20433.09	0.0	66754400	175000	7824.02	11.8	563710
September 27, 2006	421888000	0	55830.1	0.0	812400000	252000	14714.3	12.1	9844600	130800	91729.7	8.7	398615	0	20433.09	0.0	66943400	189000	7836.71	12.7	571800
September 28, 2006	421891000	3000	55830.3	0.2	812642000	242000	14726.0	11.7	10041800	197200	91742.8	13.1	398627	12	20433.09	0.0	67126700	183300	7849.00	12.3	625512
September 29, 2006	421891000	0	55830.3	0.0	812925000	283000	14739.0	13.0	10391700	349900	91766.1	23.3	398636	9	20433.09	0.0	67323600	196900	7862.25	13.3	829809
September 30, 2006	421891000	0	55830.3	0.0	813165000	240000	14751.1	12.1	10688200	296500	91785.8	19.7	398636	0	20433.09	0.0	67494100	170500	7873.70	11.4	707000
Total		2173000		138.8		9303000		454.5		3300200		218.9		15834		1.7		4704100		317.5	19496134

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
October 1, 2006	421891000	0	55830.3	0.0	813457000	292000	14765.2	14.1	11062300	374100	91810.6	24.8	398636	0	20433.09	0.0	67703700	209600	7887.80	14.1	875700
October 2, 2006	421891000	0	55830.3	0.0	813666000	209000	14775.4	10.1	11328800	266500	91828.3	17.7	398667	31	20433.19	0.1	67853600	149900	7897.93	10.1	625431
October 3, 2006	421891000	0	55830.3	0.0	813918000	252000	14787.6	12.3	11652500	323700	91849.7	21.4	398667	0	20433.19	0.0	68033800	180200	7910.16	12.2	755900
October 4, 2006	421891000	0	55830.3	0.0	814164000	246000	14799.6	12.0	11971300	318800	91870.7	21.0	398667	0	20433.19	0.0	68218300	184500	7922.67	12.5	749300
October 5, 2006	421891000	0	55830.3	0.0	814426000	262000	14812.4	12.7	12296200	324900	91892.2	21.5	398667	0	20433.19	0.0	68411900	193600	7935.80	13.1	780500
October 6, 2006	421891000	0	55830.3	0.0	814695000	269000	14825.6	13.2	12633700	337500	91914.4	22.2	398667	0	20433.19	0.0	68606000	194100	7949.10	13.3	800600
October 7, 2006	421891000	0	55830.3	0.0	814901000	206000	14835.6	10.0	12892000	258300	91931.4	17.0	398667	0	20433.19	0.0	68762100	156100	7959.10	10.0	620400
October 8, 2006	421891000	0	55830.3	0.0	815201000	300000	14850.2	14.6	13276200	384200	91956.6	25.2	398667	0	20433.19	0.0	68967400	205300	7973.70	14.6	889500
October 9, 2006	421891000	0	55830.3	0.0	815430000	229000	14861.6	11.4	13561800	285600	91975.3	18.7	398702	35	20433.19	0.0	69131050	163650	7985.02	11.3	678285
October 10, 2006	421891000	0	55830.3	0.0	815659000	229000	14872.9	11.4	13847400	285600	91994.0	18.7	398702	0	20433.19	0.0	69294700	163650	7996.34	11.3	678250
October 11, 2006	421891000	0	55830.3	0.0	815971000	312000	14888.6	15.6	14160100	312700	92014.6	20.6	398724	22	20433.19	0.0	69525100	230400	8012.40	16.1	855122
October 12, 2006	421891000	0	55830.3	0.0	816275000	304000	14903.5	14.9	14454400	294300	92033.9	19.3	398724	0	20433.19	0.0	69748200	223100	8027.75	15.4	821400
October 13, 2006	421891000	10000	55830.9	0.6	816567000	292000	14917.9	14.4	14750400	296000	92053.2	19.3	398724	0	20433.19	0.0	69959100	210900	8042.30	14.6	808900
October 14, 2006	421901000	0	55830.9	0.0	816927000	360000	14936.0	18.1	15097600	347200	92075.9	22.7	398724	0	20433.19	0.0	70218900	259800	8060.35	18.1	967000
October 15, 2006	421901000	0	55830.9	0.0	817226000	299000	14950.8	14.9	15289800	192200	92088.5	12.6	398724	0	20433.19	0.0	70444600	225700	8075.95	15.6	716900
October 16, 2006	421901000	0	55830.9	0.0	817521000	295000	14965.9	15.0	15585400	295600	92107.8	19.3	398724	0	20433.19	0.0	70650500	205900	8090.45	14.5	796500
October 17, 2006	421901000	0	55830.9	0.0	817820000	299000	14981.2	15.4	15888900	303500	92127.7	19.9	398724	0	20433.09	0.0	70866900	216400	8105.87	15.4	818900
October 18, 2006	421901000	0	55830.9	0.0	818115000	295000	14996.1	14.8	16197400	308500	92147.9	20.2	398724	0	20433.09	0.0	71121150	254250	8123.29	17.4	857750
October 19, 2006	421901000	0	55830.9	0.0	818508000	393000	15015.4	19.4	16540700	343300	92170.4	22.5	398724	0	20433.09	0.0	71375400	254250	8140.70	17.4	990550
October 20, 2006	421901000	0	55830.9	0.0	818876000	368000	15033.8	18.4	16802600	261900	92187.6	17.2	398815	91	20433.10	0.0	71644600	269200	8159.10	18.4	899191
October 21, 2006	421901000	0	55830.9	0.0	819303000	427000	15044.4	10.5	17101067	298467	92207.1	19.5	398857	42	20433.10	0.0	71954067	309467	8180.70	21.6	1034975
October 22, 2006	421901000	0	55830.9	0.0	819730000	427000	15070.7	26.3	17399533	298467	92226.7	19.5	398857	0	20433.10	0.0	72263533	309467	8202.30	21.6	1034933
October 23, 2006	421901000	0	55830.9	0.0	820157000	427000	15097.0	26.3	17698000	298467	92246.2	19.5	398857	0	20433.10	0.0	72573000	309467	8223.90	21.6	1034933
October 24, 2006	421901000	0	55830.9	0.0	820617000	460000	15121.4	24.4	18010600	312600	92266.7	20.5	399724	867	20433.20	0.1	72907500	334500	8247.46	23.6	1107967
October 25, 2006	421901000	0	55830.9	0.0	821058000	441000	15143.3	21.9	18365500	354900	92290.0	23.3	406605	6881	20434.00	0.8	73267400	359900	8272.30	24.8	1162681
October 26, 2006	421901000	0	55830.9	0.0	821492000	434000	15164.8	21.5	18624100	258600	92307.0	17.0	406607	2	20434.01	0.0	73536500	269100	8290.86	18.6	961702
October 27, 2006	421901000	0	55830.9	0.0	821922000	430000	15186.1	21.3	18954900	330800	92328.7	21.7	411367	4760	20434.50	0.5	73843600	307100	8312.10	21.2	1072660
October 28, 2006	421901000	0	55830.9	0.0	822373000	451000	15208.7	22.6	19255600	300700	92348.5	19.8	411367	0	20434.50	0.0	74167400	323800	8334.70	22.6	1075500
October 29, 2006	421901000	0	55830.9	0.0	822813500	440500	15231.4	22.7	19540150	284550	92367.3	18.8	411373	6	20434.50	0.0	74514200	346800	8356.85	22.1	1071856
October 30, 2006	421901000	0	55830.9	0.0	823254000	440500	15254.1	22.7	19824700	284550	92386.0	18.8	411373	0	20434.50	0.0	74861000	346800	8379.00	22.1	1071850
October 31, 2006	421901000	0	55830.9	0.0	823602000	348000	15271.8	17.7	20124833	300133	92405.7	19.7	398615	0	20433.50	0.0	75039133	178133	8393.20	14.2	826267
Total		10000		0.6		#######		520.7		9436633		619.9		12737		1.5		7545033		519.5	27441404

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
November 1, 2006	421901000	0	55830.1	0.0	823950000	348000	15289.6	17.7	20424967	300133	92425.5	19.7	398615	0	20433.50	0.0	75217267	178133	8407.40	14.2	826267
November 2, 2006	421901000	0	55830.1	0.0	824298000	348000	15307.3	17.7	20725100	300133	92445.2	19.7	398615	0	20433.50	0.0	75395400	178133	8421.60	14.2	826267
November 3, 2006	422079000	178000	55842.4	12.3	824597000	299000	15322.8	15.5	20989800	264700	92462.6	17.4	419629	21014	20435.58	2.1	75620100	224700	8437.45	15.9	987414
November 4, 2006	422079000	0	55842.4	0.0	824923000	326000	15339.0	16.3	21292700	302900	92482.5	19.9	420107	478	20435.60	0.0	75846600	226500	8453.10	15.6	855878
November 5, 2006	422079000	0	55842.4	0.0	825226000	303000	15354.0	15.0	21588000	295300	92502.0	19.5	420107	0	20435.60	0.0	76074500	227900	8468.70	15.6	826200
November 6, 2006	422079000	0	55842.4	0.0	825498000	272000	15367.6	13.6	21844600	256600	92518.9	16.9	420121	14	20435.62	0.0	76270800	196300	8482.29	13.6	724914
November 7, 2006	422079000	0	55842.4	0.0	825805000	307000	15383.1	15.5	22122400	277800	92537.2	18.3	420121	0	20435.62	0.0	76491700	220900	8497.83	15.5	805700
November 8, 2006	422079000	0	55842.4	0.0	826066000	261000	15396.3	13.2	22418300	295900	92556.7	19.5	420121	0	20435.60	0.0	76676300	184600	8510.70	12.9	741500
November 9, 2006	422079000	0	55842.4	0.0	826426000	360000	15414.1	17.8	22659500	241200	92578.6	21.9	420128	7	20435.62	0.0	76933200	256900	8528.27	17.6	858107
November 10, 2006	422079000	0	55842.5	0.1	826682000	256000	15426.8	12.7	22918000	258500	92589.6	11.0	420130	2	20435.62	0.0	77119000	185800	8541.05	12.8	700302
November 11, 2006	422079000	0	55842.5	0.0	826850000	168000	15435.0	8.2	23235400	317400	92610.4	20.8	420130	0	20435.62	0.0	77239100	120100	8549.10	8.1	605500
November 12, 2006	422079000	0	55842.5	0.0	827141000	291000	15449.2	14.2	23488400	253000	92627.0	16.6	420130	0	20435.62	0.0	77452200	213100	8563.49	14.4	757100
November 13, 2006	422079000	0	55842.5	0.0	827455000	314000	15464.8	15.6	23760900	272500	92644.9	17.9	420130	0	20435.62	0.0	77678400	226200	8578.97	15.5	812700
November 14, 2006	422079000	0	55842.5	0.0	827769000	314000	15480.6	15.8	24028200	267300	92662.1	17.2	420130	0	20435.62	0.0	77905600	227200	8594.70	15.7	808500
November 15, 2006	422079000	0	55842.5	0.0	828099000	330000	15496.8	16.2	24333700	305500	92681.7	19.6	420130	0	20435.62	0.0	78153900	248300	8611.50	16.8	883800
November 16, 2006	422079000	0	55842.5	0.0	828411000	312000	15512.2	15.4	24414100	80400	92687.7	6.0	420130	0	20435.62	0.0	78381900	228000	8627.00	15.5	620400
November 17, 2006	422094000	15000	55843.4	0.9	828630000	219000	15523.0	10.8	24437600	23500	92689.2	1.5	431382	11252	20436.92	1.3	78541300	159400	8637.85	10.9	428152
November 18, 2006	422094000	0	55843.6	0.2	828945500	315500	15538.5	15.5	24437600	0	92689.3	0.1	431382	0	20436.92	0.0	78777250	235950	8653.88	16.0	551450
November 19, 2006	422094000	0	55843.6	0.0	829261000	315500	15554.0	15.5	24437600	0	92689.3	0.0	431382	0	20436.92	0.0	79013200	235950	8669.91	16.0	551450
November 20, 2006	422094000	0	55843.6	0.0	829567000	306000	15569.2	15.2	24437600	0	92689.3	0.0	431382	0	20436.92	0.0	79235300	222100	8685.16	15.3	528100
November 21, 2006	422094000	0	55843.4	0.0	829864000	297000	15584.2	14.9	24485800	48200	92692.4	3.1	431382	0	20436.92	0.0	79452200	216900	8700.19	15.0	562100
November 22, 2006	422094000	0	55843.4	0.0	830269000	405000	15604.4	20.2	24505300	19500	92693.7	1.3	431481	99	20436.92	0.0	79743600	291400	8720.45	20.3	715999
November 23, 2006	422094000	0	55843.4	0.0	830566000	297000	15618.9	14.5	24505300	0	92693.7	0.0	431487	6	20436.92	0.0	79974800	231200	8736.14	15.7	528206
November 24, 2006	422094000	0	55843.4	0.0	830879000	313000	15634.3	15.4	24505300	0	92693.7	0.0	431495	8	20436.92	0.0	80204000	229200	8751.79	15.7	542208
November 25, 2006	422094000	0	55843.4	0.0	831237000	358000	15651.8	17.5	24505300	0	92693.7	0.0	433068	1573	20437.00	0.1	80460900	256900	8769.20	17.4	616473
November 26, 2006	422094000	0	55843.4	0.0	831528000	291000	15666.0	14.2	24505300	0	92693.7	0.0	434377	1309	20437.20	0.2	80674200	213300	8783.70	14.5	505609
November 27, 2006	422094000	0	55843.4	0.0	831818000	290000	15680.7	14.7	24505300	0	92693.7	0.0	434409	32	20437.26	0.1	80881300	207100	8798.04	14.3	497132
November 28, 2006	422094000	0	55843.4	0.0	832125000	307000	15695.8	15.1	24627600	122300	92701.6	7.9	434409	0	20437.26	0.0	81107600	226300	8813.77	15.7	655600
November 29, 2006	422094000	0	55843.4	0.0	832383000	258000	15708.6	12.7	24627600	0	92701.6	0.0	434409	0	20437.26	0.0	81293100	185500	8826.47	12.7	443500
November 30, 2006	422094000	0	55843.4	0.0	832714000	331000	15724.7	16.2	24627600	0	92701.6	0.0	434471	62	20437.26	0.0	81534300	241200	8842.79	16.3	572262
		193000		13.5		9112000		452.9		4502767		295.9		35856		3.8		6495167		449.6	20338789

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
December 1, 2006	422094000	0	55843.4	0.0	833022000	308000	15740.0	z	24627600	0	92701.6	0.0	437818	3347	20437.26	0.0	81755900	221600	8858.00	15.2	532947
December 2, 2006	422094000	0	55843.4	0.0	833297000	275000	15753.5	13.5	24628800	1200	92701.7	0.1	437829	11	20437.66	0.4	81958600	202700	8871.89	13.9	478911
December 3, 2006	422094000	0	55843.4	0.0	833642000	345000	15770.0	16.5	24628800	0	92701.7	0.0	437834	5	20437.60	0.0	82221200	262600	8889.10	17.2	607605
December 4, 2006	422094000	0	55843.4	0.0	833916000	274000	15783.9	13.9	24628800	0	92701.7	0.0	437835	i	20437.66	0.1	82406300	185100	8902.45	13.4	459101
December 5, 2006	422094000	0	55843.4	0.0	834235000	319000	15800.0	16.1	24630200	1400	92701.8	0.1	437835	0	20437.66	0.0	82636900	230600	8918.62	16.2	551000
December 6, 2006	422097000	3000	55843.6	0.2	834547000	312000	15815.5	15.5	24630700	500	92701.8	0.0	439473	1638	20437.90	0.2	82869000	232100	8934.54	15.9	549238
December 7, 2006	422097000	0	55843.6	0.0	834894000	347000	15832.2	16.7	24630700	0	92701.8	0.0	439659	186	20437.92	0.0	83118000	249000	8951.40	16.9	596186
December 8, 2006	422097000	0	55843.6	0.0	835182000	288000	15846.4	14.2	24633700	3000	92702.3	0.5	439659	0	20437.92	0.0	83324700	206700	8965.45	14.1	497700
December 9, 2006	422097000	0	55843.6	0.0	835492000	310000	15861.5	15.1	24633700	0	92702.3	0.0	439659	0	20437.92	0.0	83554900	230200	8981.04	15.6	540200
December 10, 2006	422097000	0	55843.6	0.0	835800000	308000	15876.4	14.9	24633700	0	92702.3	0.0	439659	0	20437.92	0.0	83780200	225300	8996.23	15.2	533300
December 11, 2006	422097000	0	55843.6	0.0	836121667	321667	15892.1	15.7	24635300	1600	92704.8	2.5	439659	0	20437.92	0.0	84011967	231767	9012.07	15.8	555033
December 12, 2006	422097000	0	55843.6	0.0	836443333	321667	15907.8	15.7	24635300	0	92704.8	0.0	439659	0	20437.92	0.0	84243733	231767	9027.92	15.8	553433
December 13, 2006	422097000	0	55843.6	0.0	836765000	321667	15923.6	15.7	24635300	0	92704.8	0.0	439659	0	20437.92	0.0	84475500	231767	9043.76	15.8	553433
December 14, 2006	422097000	0	55843.6	0.0	837076000	311000	15938.7	15.i	24635300	0	92704.8	0.0	439659	0	20437.92	0.0	84704400	228900	9059.34	15.6	539900
December 15, 2006	422097000	0	55843.6	0.0	837405000	329000	15954.8	16.1	24635300	0	92704.8	0.0	439659	0	20437.92	0.0	84939200	234800	9075.44	16.1	563800
December 16, 2006	422100000	3000	55843.8	0.2	837781000	376000	15973.4	18.6	24832000	196700	92714.0	9.2	441934	2275	20438.70	0.8	85220000	280800	9094.40	19.0	858775
December 17, 2006	422100000	0	55843.8	0.0	838105000	324000	15988.5	15.i	24832000	0	92714.0	0.0	441934	0	20438.70	0.0	85450000	230000	9111.00	16.6	554000
December 18, 2006	422101000	1000	55843.8	0.0	838360000	255000	16001.5	13.0	24861500	29500	92715.3	1.3	441934	0	20438.70	0.0	85627400	177400	9122.75	11.8	462900
December 19, 2006	422101000	0	55843.8	0.0	838684000	324000	16017.7	16.2	25178300	316800	92729.9	14.6	441934	0	20438.70	0.0	85857500	230100	9139.00	16.3	870900
December 20, 2006	422101000	0	55843.8	0.0	839023000	339000	16034.5	16.7	25554900	376600	92746.8	16.9	441934	0	20438.70	0.0	86107600	250100	9156.42	17.4	965700
December 21, 2006	422101000	0	55843.8	0.0	839341000	318000	16050.1	15.6	25613500	58600	92749.4	2.6	441934	0	20438.70	0.0	86343600	236000	9172.69	16.3	612600
December 22, 2006	422100000	0	55843.8	0.0	839662000	321000	16066.1	16.0	25637100	23600	92750.5	1.1	442056	122	20438.70	0.0	86571000	227400	9188.70	16.0	572122
December 23, 2006	422100000	0	55843.8	0.0	839946000	284000	16079.0	12.9	25695000	57900	92753.0	2.5	442056	0	20438.70	0.0	86783400	212400	9203.00	14.3	554300
December 24, 2006	422100000	0	55843.8	0.0	840276000	330000	16096.0	17.0	25712000	17000	92753.0	0.0	442056	0	20438.70	0.0	87020000	236600	9219.20	16.2	583600
December 25, 2006	422100000	0	55843.8	0.0	840583500	307500	16111.3	15.3	25725450	13450	92754.0	1.0	442056	0	20438.70	0.0	87241300	221300	9234.90	15.7	542250
December 26, 2006	422100000	0	55843.8	0.0	840891000	307500	16126.7	15.3	25738900	13450	92755.0	1.0	442056	0	20438.70	0.0	87462600	221300	9250.60	15.7	542250
December 27, 2006	422100000	0	55843.8	0.0	841240000	349000	16143.0	16.3	25775000	36100	92756.0	1.0	442056	0	20438.70	0.0	87709000	246400	9267.00	16.4	631500
December 28, 2006	422100000	0	55843.8	0.0	841574000	334000	16159.9	16.9	26078800	303800	92769.9	13.9	442056	0	20438.70	0.0	87951700	242700	9284.22	17.2	880500
December 29, 2006	422100000	0	55843.8	0.0	841895000	321000	16175.7	15.8	26428700	349900	92785.1	15.2	442056	0	20438.70	0.0	88178500	226800	9299.84	15.6	897700
December 30, 2006	422100000	0	55843.8	0.0	842185000	290000	16189.5	13.8	26761000	332300	92799.1	14.0	442056	0	20438.70	0.0	88389000	210500	9314.20	14.4	832800
December 31, 2006	422100000	0	55843.8	0.0	842446500	261500	16202.4	12.9	27029250	268250	92810.9	11.8	422918	0	20438.51	0.0	88576600	187600	9326.60	12.4	717350
Total		7000		0.4		9732500		462.4		2401650		109.3		7585		1.5		7042300		483.8	19191035

*** Missing readings for 11, 12, 25 and 31 December 2006 *** Data has been averaged

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
January 1, 2007	422100000	0	55843.8	0.0	842708000	261500	16215.3	12.9	27297500	268250	92822.7	11.8	442918	0	20438.51	0.0	88764200	187600	9339.00	12.4	717350
January 2, 2007	422100000	0	55843.8	0.0	843015000	307000	16230.3	15.0	27640400	342900	92837.5	14.8	442952	34	20438.51	0.0	88986500	222300	9355.07	16.1	872234
January 3, 2007	422100000	0	55843.8	0.0	843341000	326000	16246.1	15.9	27989500	349100	92852.5	15.0	443010	58	20438.51	0.0	89213500	227000	9370.53	15.5	902158
January 4, 2007	422100000	0	55843.8	0.0	843668000	327000	16262.1	16.0	28342300	352800	92867.7	15.2	443081	71	20438.51	0.0	89445900	232400	9386.50	16.0	912271
January 5, 2007	422100000	0	55843.8	0.0	844015000	347000	16279.2	17.1	28706900	364600	92883.4	15.7	443146	65	20438.51	0.0	89696700	250800	9403.87	17.4	962465
January 6, 2007	422100000	0	55843.8	0.0	844312000	297000	16293.8	14.6	28957100	250200	92894.1	10.7	443194	48	20438.51	0.0	89908100	211400	9418.40	14.5	758648
January 7, 2007	422100000	0	55843.8	0.0	844624000	312000	16309.0	15.2	28957000	0	92894.1	0.0	443210	16	20438.51	0.0	90126100	218000	9433.00	14.6	530016
January 8, 2007	422100000	0	55843.8	0.0	844962000	338000	16325.0	16.0	28957000	0	92894.1	0.0	443253	43	20438.51	0.0	90377500	251400	9450.00	17.0	589443
January 9, 2007	422100000	0	55843.8	0.0	845318000	356000	16343.0	18.0	29236800	279800	92906.2	12.1	443286	33	20438.51	0.0	90625300	247800	9467.55	17.5	883633
January 10, 2007	422100000	0	55843.8	0.0	845658000	340000	16359.5	16.5	29603000	366200	92921.9	15.7	443319	33	20438.51	0.0	90881300	256000	9484.99	17.4	962233
January 11, 2007	422100000	0	55843.8	0.0	845993000	335000	16375.9	16.4	29950800	347800	92936.8	14.9	443348	29	20438.51	0.0	91116900	235600	9501.21	16.2	918429
January 12, 2007	422100000	0	55843.8	0.0	846315000	322000	16391.8	15.9	30295100	344300	92951.5	14.7	443413	65	20438.51	0.0	91346900	230000	9517.21	16.0	896365
January 13, 2007	422100000	0	55843.8	0.0	846609000	294000	16406.0	14.2	30604700	309600	92964.8	13.3	443425	12	20438.51	0.0	91558700	211800	9531.70	14.5	815412
January 14, 2007	422100000	0	55843.8	0.0	846979000	370000	16423.9	17.8	30957700	353000	92979.9	15.1	443437	12	20438.51	0.0	91827500	268800	9550.08	18.4	991812
January 15, 2007	422100000	0	55843.8	0.0	847314000	335000	16440.1	16.2	31287100	329400	92993.9	14.0	443463	26	20438.51	0.0	92065000	237500	9566.43	16.4	901926
January 16, 2007	422100000	0	55843.8	0.0	847619000	305000	16454.8	14.7	31585800	298700	93006.7	12.8	443495	32	20438.51	0.0	92264800	199800	9580.20	13.8	803532
January 17, 2007	422100000	0	55843.8	0.0	847950000	331000	16470.8	16.0	31931000	345200	93021.4	14.7	443512	17	20438.51	0.0	92521300	256500	9597.81	17.6	932717
January 18, 2007	422103000	3000	55843.9	0.1	848277000	327000	16486.4	15.7	32255400	324400	93035.2	13.8	444419	907	20438.67	0.2	92754400	233100	9613.83	16.0	888407
January 19, 2007	422105000	2000	55844.1	0.2	848609000	332000	16502.4	16.0	32590400	335000	93049.4	14.2	445212	793	20438.81	0.1	92975500	221100	9629.10	15.3	890893
January 20, 2007	422105000	0	55844.1	0.0	848938000	329000	16518.3	15.9	32910600	320200	93063.0	13.6	445212	0	20438.81	0.0	93215600	240100	9645.70	16.6	889300
January 21, 2007	422105000	0	55844.1	0.0	849293000	355000	16535.3	17.0	33247400	336800	93077.3	14.3	445212	0	20438.81	0.0	93459800	244200	9662.57	16.9	936000
January 22, 2007	422105000	0	55844.1	0.0	849595000	302000	16549.9	14.6	33542700	295300	93089.8	12.5	445225	13	20438.81	0.0	93672100	212300	9677.30	14.7	809613
January 23, 2007	422105000	0	55844.1	0.0	849954000	359000	16567.2	17.3	33880100	337400	93104.1	14.3	445238	13	20438.81	0.0	93924700	252600	9694.76	17.5	949013
January 24, 2007	422105000	0	55844.1	0.0	850287000	333000	16583.1	15.9	34208100	328000	93118.0	13.9	445253	15	20438.81	0.0	94161600	236900	9711.03	16.3	897915
January 25, 2007	422105000	0	55844.1	0.0	850622000	335000	16599.2	16.0	34524300	316200	93131.4	13.4	445278	25	20438.81	0.0	94393500	231900	9727.07	16.0	883125
January 26, 2007	422105000	0	55844.1	0.0	850972000	350000	16616.0	16.9	34864900	340600	93145.8	14.4	445301	23	20438.81	0.0	94634900	241400	9743.88	16.8	932023
January 27, 2007	422105000	0	55844.1	0.0	851306000	334000	16632.2	16.2	35189700	324800	93159.6	13.8	445316	15	20438.81	0.0	94874600	239700	9760.61	16.7	898515
January 28, 2007	422105000	0	55844.1	0.0	851612000	306000	16646.7	14.5	35492200	302500	93172.4	12.8	445338	22	20438.81	0.0	95091000	216400	9775.50	14.9	824922
January 29, 2007	422105000	0	55844.1	0.0	851963000	351000	16663.4	16.7	35824700	332500	93186.5	14.1	445360	22	20438.81	0.0	95334300	243300	9792.30	16.8	926822
January 30, 2007	422105000	0	55844.1	0.0	852307000	344000	16679.8	16.4	36153900	329200	93200.4	13.9	445382	22	20438.81	0.0	95572900	238600	9808.88	16.6	911822
January 31, 2007	422105000	0	55844.1	0.0	852655000	348000	16696.5	16.7	36479700	325800	93214.2	13.8	445405	23	20438.81	0.0	95816400	243500	9825.70	16.8	917323
Total		5000		0.3		#######		494.1		9450550		403.3		2487		0.3		7239800		499.1	26906337

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
February 1, 2007	422105000	0	55844.1	0.0	852992000	337000	16712.5	16.0	36794300	314600	93227.5	13.3	445427	22	20438.81	0.0	96046500	230100	9841.75	16.0	881722
February 2, 2007	422105000	0	55844.1	0.0	853270000	278000	16725.6	13.1	37084700	290400	93239.8	12.3	445452	25	20438.81	0.0	96244500	198000	9855.37	13.6	766425
February 3, 2007	422105000	0	55844.1	0.0	853627000	357000	16742.5	16.9	37420700	336000	93254.0	14.2	445484	32	20438.81	0.0	96503900	259400	9873.21	17.8	952432
February 4, 2007	422105000	0	55844.1	0.0	853980000	353000	16759.1	16.6	37747800	327100	93267.9	13.9	445515	31	20438.81	0.0	96735500	231600	9889.18	16.0	911731
February 5, 2007	422105000	0	55844.1	0.0	854300000	320000	16774.3	15.1	38039200	291400	93280.2	12.3	445543	28	20438.81	0.0	96954100	218600	9904.31	15.1	830028
February 6, 2007	422105000	0	55844.1	0.0	854615000	315000	16789.3	15.0	38337900	298700	93292.9	12.7	445565	22	20438.81	0.0	97175700	221600	9919.73	15.4	835322
February 7, 2007	422105000	0	55844.1	0.0	854971000	356000	16806.2	16.8	38653500	315600	93306.7	13.8	445593	28	20438.81	0.0	97418900	243200	9936.64	16.9	914828
February 8, 2007	422105000	0	55844.1	0.0	855330000	359000	16823.1	16.9	38982500	329000	93320.2	13.5	445627	34	20438.81	0.0	97666600	247700	9953.85	17.2	935734
February 9, 2007	422105000	0	55844.1	0.0	855688000	358000	16840.3	17.2	39305900	323400	93334.0	13.8	445659	32	20438.81	0.0	97909700	243100	9971.07	17.2	924532
February 10, 2007	422105000	0	55844.1	0.0	855989000	301000	16854.6	14.4	39619200	313300	93347.3	13.3	445689	30	20438.81	0.0	98117900	208200	9985.83	14.8	822530
February 11, 2007	422105000	0	55844.1	0.0	856380000	391000	16873.0	18.4	39909200	290000	93359.6	12.3	445755	66	20438.81	0.0	98386700	268800	4.74	18.9	949866
February 12, 2007	422105000	0	55844.1	0.0	856678000	298000	16887.4	14.3	40163100	253900	93370.4	10.8	445793	38	20438.80	0.0	98579500	192800	18.49	13.8	744738
February 13, 2007	422105000	0	55844.1	0.0	857022000	344000	16903.8	16.5	40500100	337000	93384.8	14.4	447048	1255	20439.04	0.2	98817600	238100	35.40	16.9	920355
February 14, 2007	422105000	0	55844.1	0.0	857350000	328000	16919.3	15.4	40786700	286600	93397.1	12.3	447061	13	20439.04	0.0	99036900	219300	50.92	15.5	833913
February 15, 2007	422105000	0	55844.1	0.0	857707500	357500	16936.6	17.3	41034550	247850	93407.7	10.5	447084	23	20439.04	0.0	99275100	238200	68.24	17.3	843573
February 16, 2007	422105000	0	55844.1	0.0	858065000	357500	16953.9	17.3	41282400	247850	93418.2	10.6	447084	0	20439.04	0.0	99513300	238200	85.56	17.3	843550
February 17, 2007	422105000	0	55844.1	0.0	858286000	221000	16964.5	10.5	41672100	389700	93434.8	16.6	447134	50	20439.04	0.0	99668600	155300	96.57	11.0	766050
February 18, 2007	422105000	0	55844.1	0.0	858441500	155500	16971.9	7.5	41939250	267150	93446.2	11.4	447191	57	20439.04	0.0	99773900	105300	104.09	7.5	528007
February 19, 2007	422105000	0	55844.1	0.0	858597000	155500	16979.4	7.5	42206400	267150	93457.6	11.4	447191	0	20439.04	0.0	99879200	105300	111.60	7.5	527950
February 20, 2007	422108000	3000	55844.2	0.1	858750000	153000	16986.9	7.5	42463600	257200	93468.6	11.0	447213	22	20439.04	0.0	99978900	99700	118.87	7.3	512922
February 21, 2007	422108000	0	55844.2	0.0	858930000	180000	16995.4	8.5	42765400	301800	93481.5	12.9	447244	31	20439.04	0.0	103800	124900	127.68	8.8	606731
February 22, 2007	422108000	0	55844.2	0.0	859099000	169000	17003.2	7.8	43061300	295900	93494.3	12.8	447271	27	20439.04	0.0	212000	108200	135.14	7.5	573127
February 23, 2007	422108000	0	55844.2	0.0	859281000	182000	17011.7	8.4	43356200	294900	93506.9	12.6	447305	34	20439.04	0.0	331100	119100	143.38	8.2	596034
February 24, 2007	422108000	0	55844.2	0.0	859582000	301000	17025.6	14.0	43630700	274500	93518.7	11.8	447326	21	20439.04	0.0	534500	203400	157.49	14.1	778921
February 25, 2007	422108000	0	55844.2	0.0	859939000	357000	17042.5	16.9	43913300	282600	93530.9	12.2	447345	19	20439.04	0.0	769000	234500	174.07	16.6	874119
February 26, 2007	422108000	0	55844.2	0.0	860276000	337000	17058.5	16.0	44205800	292500	93543.5	12.6	447365	20	20439.04	0.0	999500	230500	190.46	16.4	860020
February 27, 2007	422108000	0	55844.2	0.0	860635000	359000	17076.0	17.5	44463600	257800	93554.6	11.1	447386	21	20439.04	0.0	1241800	242300	207.97	17.5	859121
February 28, 2007	422108000	0	55844.2	0.0	861010000	375000	17093.9	17.9	44753900	290300	93567.1	12.5	447405	19	20439.04	0.0	1453600	211800	225.64	17.7	877119
Total		3000		0.1		8355000		397.4		8274200		352.9		2000		0.2		5637200		399.9	22271400

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
March 1, 2007	422108000	0	55844.3	0.1	861355000	345000	17110.0	16.1	45020300	266400	93578.6	11.5	447418	13	20439.04	0.0	1721800	268200	241.94	16.3	879613
March 2, 2007	422108000	0	55844.2	0.0	861715000	360000	17126.9	16.9	45297000	276700	93590.6	12.0	447438	20	20439.04	0.0	1953900	232100	253.25	11.3	868820
March 3, 2007	422119000	11000	55844.9	0.7	862126000	411000	17148.5	21.6	45566000	269000	93602.2	11.6	451485	4047	20439.06	0.0	2227800	273900	277.82	24.6	968947
March 4, 2007	422119000	0	55844.9	0.0	862623000	497000	17170.2	21.7	45838200	272200	93613.9	11.7	451490	5	20439.86	0.8	2557200	329400	301.32	23.5	1098605
March 5, 2007	422119000	0	55844.9	0.0	862992000	369000	17188.3	18.2	46096950	258750	93625.1	11.2	451516	26	20439.86	0.0	2803200	246000	319.53	18.2	873776
March 6, 2007	422119000	0	55844.9	0.0	863361000	369000	17206.5	18.2	46355700	258750	93636.2	11.1	451516	0	20439.86	0.0	3049200	246000	337.74	18.2	873750
March 7, 2007	422119000	0	55844.9	0.0	863753000	392000	17225.5	19.0	46643900	288200	93648.7	12.5	451538	22	20439.86	0.0	3302300	253100	356.26	18.5	933322
March 8, 2007	422119000	0	55844.9	0.0	864120000	367000	17243.1	17.6	46905500	261600	93660.0	11.3	451556	18	20439.86	0.0	3547300	245000	373.92	17.7	873618
March 9, 2007	422119000	0	55844.9	0.0	864493000	373000	17261.3	18.1	47166800	261300	93671.2	11.2	451984	428	20439.93	0.1	3791900	244600	391.62	17.7	879328
March 10, 2007	422119000	0	55844.9	0.0	864836000	343000	17277.7	16.5	47418700	251900	93682.7	11.5	451994	10	20439.93	0.0	4025700	233800	408.44	16.8	828710
March 11, 2007	422119000	0	55844.9	0.0	865172000	336000	17294.2	16.5	47667400	248700	93692.9	10.2	452009	15	20439.93	0.0	4251400	225700	424.96	16.5	810415
March 12, 2007	422120000	1000	55845.0	0.1	865523000	351000	17310.8	16.6	47929900	262500	93704.2	11.3	452025	16	20439.93	0.0	4481200	229800	441.19	16.2	844316
March 13, 2007	422120000	0	55845.0	0.0	865928000	405000	17330.5	19.7	48196300	266400	93715.7	11.5	452042	17	20439.93	0.0	4748700	267500	460.65	19.5	938917
March 14, 2007	422120000	0	55845.0	0.0	866308000	380000	17348.6	18.1	48445400	249100	93726.4	10.7	452064	22	20439.93	0.0	4992400	243700	478.11	17.5	872822
March 15, 2007	422120000	0	55845.0	0.0	866636000	328000	17364.1	15.5	48663400	218000	93735.7	9.3	452070	6	20439.53	0.0	5210900	218500	493.71	15.6	764506
March 16, 2007	422184000	64000	55849.2	4.2	867072000	436000	17385.4	21.3	48981100	317700	93749.3	13.6	473623	21553	20444.28	4.8	5437000	226100	510.22	16.5	1065353
March 17, 2007	422184000	0	55849.2	0.0	867343000	271000	17398.3	12.9	49289100	308000	93759.1	9.8	473623	0	20444.28	0.0	5615000	178000	522.92	12.7	757000
March 18, 2007	422184000	0	55849.2	0.0	867693500	350500	17415.0	16.8	49512250	223150	93770.4	11.3	473623	0	20444.28	0.0	5849300	234300	539.67	16.8	807950
March 19, 2007	422184000	0	55849.2	0.0	868044000	350500	17431.8	16.8	49735400	223150	93781.7	11.3	473623	0	20444.28	0.0	6083600	234300	556.42	16.8	807950
March 20, 2007	422188000	4000	55849.5	0.3	868354000	310000	17446.7	14.9	49954800	219400	93791.1	9.4	476244	2621	20444.76	0.5	6278000	194400	570.54	14.1	730421
March 21, 2007	422188000	0	55849.5	0.0	868737000	383000	17465.3	18.6	50227000	272200	93802.8	11.7	476244	0	20444.76	0.0	6530800	252800	588.95	18.4	908000
March 22, 2007	422188000	0	55849.5	0.0	868976000	239000	17476.7	11.4	50459550	232550	93812.8	10.0	476244	0	20444.76	0.0	6686050	155250	600.11	11.2	626800
March 23, 2007	422188000	0	55849.5	0.0	869215000	239000	17488.1	11.4	50692100	232550	93822.8	10.0	476244	0	20444.76	0.0	6841300	155250	611.27	11.2	626800
March 24, 2007	422188000	0	55849.5	0.0	869407000	192000	17497.2	9.1	50937000	244900	93833.2	10.4	476244	0	20444.76	0.0	6968500	127200	620.28	9.0	564100
March 25, 2007	422188000	0	55849.5	0.0	869738000	331000	17513.1	15.9	51176900	239900	93843.5	10.3	476244	0	20444.76	0.0	7185100	216600	635.99	15.7	787500
March 26, 2007	422188000	0	55849.5	0.0	870036000	298000	17527.7	14.6	51404900	228000	93853.3	9.8	476245	1	20444.76	0.0	7384600	199500	650.74	14.8	725501
March 27, 2007	422188000	0	55849.5	0.0	870356000	320000	17543.2	15.5	51633600	228700	93863.1	9.8	476245	0	20444.76	0.0	7593300	208700	666.07	15.3	757400
March 28, 2007	422188000	0	55849.5	0.0	870695000	339000	17559.5	16.3	51865700	232100	93873.1	10.0	476245	0	20444.76	0.0	7816800	223500	682.37	16.3	794600
March 29, 2007	422188000	0	55849.5	0.0	871041000	346000	17576.5	17.0	52092000	226300	93882.7	9.6	476245	0	20444.76	0.0	8036000	219200	698.69	16.3	791500
March 30, 2007	422188000	0	55849.5	0.0	871379000	338000	17592.7	16.2	52314700	222700	93892.4	9.7	476246	1	20444.76	0.0	8253000	217000	714.49	15.8	777701
March 31, 2007	422188000	0	55849.5	0.0	871702000	323000	17608.2	15.5	52541300	226600	93901.8	9.4	536869	60623	20456.43	11.7	8462800	209800	729.86	15.4	820023
Total		80000		5.4		10692000		514.3		7787400		334.7		89464		17.8		7009200		504.2	25658064

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
April 1, 2007	422188000	0	55849.5	0.0	871979000	277000	17621.9	13.7	52762700	221400	93911.3	9.5	607807	70938	20409.97	0.0	8643200	180400	743.49	13.6	749738
April 2, 2007	422190000	2000	55849.6	0.1	872245000	266000	17635.2	13.3	52981900	219200	93920.3	9.0	678039	70232	20483.44	73.5	8818200	175000	756.95	13.5	732432
April 3, 2007	422190000	0	55849.6	0.0	872532000	287000	17649.3	14.1	53209100	227200	93930.3	10.0	751156	73117	20497.12	13.7	9002900	184700	770.97	14.0	772017
April 4, 2007	422190000	0	55849.6	0.0	872795000	263000	17662.0	12.7	53440500	231400	93940.2	9.9	819731	68575	20509.62	12.5	9176200	173300	783.71	12.7	736275
April 5, 2007	422190000	0	55849.6	0.0	873054000	259000	17674.7	12.7	53672400	231900	93950.1	9.9	887630	67899	20522.12	12.5	9342600	166400	796.15	12.4	725199
April 6, 2007	422190000	0	55849.6	0.0	873359000	305000	17689.7	15.0	53903800	231400	93959.9	9.8	964191	76561	20536.28	14.2	9529500	186900	810.20	14.1	799861
April 7, 2007	422190000	0	55849.6	0.0	873631000	272000	17702.8	13.1	54126900	223100	93969.4	9.5	1039615	75424	20549.93	13.7	9711400	181900	823.64	13.4	752424
April 8, 2007	422190000	0	55849.6	0.0	873836000	205000	17712.8	10.0	54389400	262500	93980.6	11.2	1093660	54045	20559.70	9.8	9846900	135500	833.76	10.1	657045
April 9, 2007	422190000	0	55849.6	0.0	873958000	122000	17718.7	5.8	54643200	253800	93991.4	10.8	1121064	27404	20565.17	5.5	9919300	72400	839.15	5.4	475604
April 10, 2007	422190000	0	55849.6	0.0	874083000	125000	17724.8	6.1	55070100	426900	94009.6	18.2	1158816	37752	20571.47	6.3	10002700	83400	845.38	6.2	673052
April 11, 2007	422190000	0	55849.6	0.0	874170000	87000	17729.0	4.2	55632200	562100	94033.6	24.0	1181872	23056	20575.66	4.2	10059700	57000	849.57	4.2	729156
April 12, 2007	422190000	0	55849.6	0.0	874255000	85000	17733.0	4.0	56193500	561300	94057.6	24.0	1202700	20828	20579.45	3.8	10111000	51300	853.36	3.8	718428
April 13, 2007	422190000	0	55849.6	0.0	874351000	96000	17737.6	4.6	56731000	537500	94080.5	22.9	1225813	23113	20583.62	4.2	10167500	56500	857.51	4.1	713113
April 14, 2007	422190000	0	55849.6	0.0	874428000	77000	17741.3	3.7	57247900	516900	94102.5	22.0	1246366	20553	20587.28	3.7	10217600	50100	861.20	3.7	664553
April 15, 2007	422190000	0	55849.6	0.0	874507000	79000	17745.0	3.8	57819400	571500	94126.8	24.3	1267365	20999	20591.04	3.8	10269000	51400	864.96	3.8	722899
April 16, 2007	422190000	0	55849.6	0.0	874567000	60000	17747.9	2.9	58295700	476300	94147.1	20.3	1283013	15648	20593.83	2.8	10307100	38100	867.75	2.8	590048
April 17, 2007	422190000	0	55849.6	0.0	874645000	78000	17751.6	3.7	58874700	579000	94171.7	24.6	1302465	19452	20597.31	3.5	10354900	47800	871.23	3.5	724252
April 18, 2007	422190000	0	55849.6	0.0	874708000	63000	17754.6	3.0	59466000	591300	94196.7	25.0	1319204	16739	20600.29	3.0	10396100	41200	874.22	3.0	712239
April 19, 2007	422190000	0	55849.6	0.0	874828000	120000	17760.4	5.7	60025200	559200	94220.4	23.7	1349358	30154	20605.68	5.4	10475500	79400	879.98	5.8	788754
April 20, 2007	422190000	0	55849.6	0.0	874980000	152000	17767.6	7.2	60586700	561500	94244.1	23.7	1387751	38393	20612.54	6.9	10577200	101700	887.34	7.4	853593
April 21, 2007	422190000	0	55849.6	0.0	875115000	135000	17774.0	6.4	61141700	555000	94267.5	23.4	1424344	36593	20619.09	6.5	10665600	88400	893.75	6.4	814993
April 22, 2007	422190000	0	55849.6	0.0	875265000	150000	17781.3	7.3	61695800	554100	94290.8	23.3	1464686	40342	20626.36	7.3	10764700	99100	901.06	7.3	843542
April 23, 2007	422194000	4000	55849.8	0.2	875418000	153000	17788.7	7.4	62238800	543000	94313.7	22.9	1505965	41279	20633.79	7.4	10865300	100600	908.56	7.5	841879
April 24, 2007	422196000	2000	55849.9	0.1	875575000	157000	17796.4	7.7	62770000	531200	94336.1	22.4	1548998	43033	20641.56	7.8	10968500	103200	916.19	7.6	836433
April 25, 2007	422196000	0	55849.9	0.0	875742000	167000	17804.5	8.1	63341400	571400	94359.9	23.8	1591156	42158	20648.97	7.4	11071100	102600	923.89	7.7	883158
April 26, 2007	422196000	0	55849.9	0.0	875898000	156000	17812.0	7.5	63899000	557600	94383.3	23.4	1633200	42044	20656.43	7.5	11173600	102500	931.26	7.4	858144
April 27, 2007	422196000	0	55849.9	0.0	876074000	176000	17820.5	8.4	64484100	585100	94407.8	24.5	1677426	44226	20664.29	7.9	11283400	109800	939.26	8.0	915126
April 28, 2007	422196000	0	55849.9	0.0	876229000	155000	17827.8	7.4	64991700	507600	94429.0	21.2	1720238	42812	20671.06	6.8	11385600	102200	946.74	7.5	807612
April 29, 2007	422196000	0	55849.9	0.0	876409000	180000	17836.7	8.8	65565600	573900	94453.0	24.0	1768205	47967	20680.41	9.3	11509500	123900	955.98	9.2	925767
April 30, 2007	422196000	0	55849.9	0.0	876718000	309000	17851.9	15.3	66191800	626200	94479.1	26.1	1852758	84553	20695.87	15.5	11706100	196600	970.71	14.7	1216353
Total		8000		0.4		5016000		243.7		13650500		577.3		1315889		285.9		3243300		240.9	23233689

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
May 1, 2007	422196000	0	55849.9	0.0	877157000	439000	17873.6	21.6	66761000	569200	94502.9	23.8	1868232	15474	20698.74	2.9	11990700	284600	992.33	21.6	1308274
May 2, 2007	422196000	0	55849.9	0.0	877518000	361000	17891.2	17.6	67327500	566500	94526.5	23.6	1868232	0	20698.74	0.0	12292900	302200	1014.72	22.4	1229700
May 3, 2007	422196000	0	55849.9	0.0	877518000	0	17891.2	0.0	67852000	524500	94548.3	21.8	1868232	0	20698.74	0.0	12616000	323100	1036.94	22.2	847600
May 4, 2007	422196000	0	55849.9	0.0	877518000	0	17891.2	0.0	68469800	617800	94574.0	25.7	1868232	0	20698.74	0.0	12984500	368500	1062.38	25.4	986300
May 5, 2007	422196000	0	55849.9	0.0	877518000	0	17891.2	0.0	69009800	540000	94596.4	22.4	1868232	0	20698.74	0.0	13336800	352300	1086.70	24.3	892300
May 6, 2007	422196000	0	55849.9	0.0	877518000	0	17891.2	0.0	69573400	563600	94619.7	23.3	1868232	0	20698.74	0.0	13675200	338400	1110.35	23.6	902000
May 7, 2007	422196000	0	55849.9	0.0	877518000	0	17891.2	0.0	70094700	521300	94641.3	21.6	1868232	0	20698.74	0.0	14005600	330400	1133.52	23.2	851700
May 8, 2007	422196000	0	55849.9	0.0	877519000	1000	17891.2	0.0	70679800	585100	94665.5	24.2	1868232	0	20698.74	0.0	14353100	347500	1157.95	24.4	933600
May 9, 2007	422196000	0	55849.9	0.0	877720000	201000	17900.9	9.7	71246000	566200	94688.9	23.4	1868232	0	20698.74	0.0	14687400	334300	1181.70	23.8	1101500
May 10, 2007	422196000	0	55849.9	0.0	878087000	367000	17918.4	17.5	71833600	587600	94713.1	24.2	1925448	57216	20709.10	10.4	14934900	247500	1199.66	18.0	1259316
May 11, 2007	422196000	0	55849.9	0.0	878417000	330000	17934.6	16.1	72410400	576800	94737.0	23.9	2013488	88040	20724.99	15.9	15156400	221500	1215.89	16.2	1216340
May 12, 2007	422196000	0	55849.9	0.0	878806000	389000	17953.6	19.0	72861200	450800	94755.5	18.5	2114007	100519	20743.52	18.5	15407000	250600	1234.53	18.6	1190919
May 13, 2007	422196000	0	55849.9	0.0	879180000	374000	17971.6	18.0	73263100	401900	94772.1	16.6	2212022	98015	20761.59	18.1	15648700	241700	1252.32	17.8	1115615
May 14, 2007	422196000	0	55849.9	0.0	879503000	323000	17987.0	15.4	73603200	340100	94786.0	13.9	2294430	82408	20776.80	15.2	15860500	211800	1267.75	15.4	957308
May 15, 2007	422198000	2000	55850.1	0.2	879827000	324000	18002.5	15.5	73942800	339600	94799.9	13.9	2375262	80832	20791.81	15.0	16064000	203500	1282.60	14.8	949932
May 16, 2007	422198000	0	55850.1	0.0	880239000	412000	18021.8	19.3	74493500	550700	94822.4	22.5	2477931	102669	20810.69	18.9	16299000	235000	1297.60	15.0	1300369
May 17, 2007	422198000	0	55850.1	0.0	880570000	331000	18037.9	16.1	75016700	523200	94843.8	21.4	2562743	84812	20826.81	16.1	16480200	181200	1313.26	15.7	1120212
May 18, 2007	422198000	0	55850.1	0.0	881000000	430000	18059.2	21.3	75663400	646700	94870.3	26.5	2671700	108957	20847.65	20.8	16751900	271700	1334.07	20.8	1457357
May 19, 2007	422198000	0	55850.1	0.0	881329000	329000	18075.0	15.8	76247100	583700	94894.2	23.9	2754592	82892	20863.18	15.5	16959600	207700	1349.52	15.5	1203292
May 20, 2007	422198000	0	55850.1	0.0	881634000	305000	18089.5	14.4	76661400	414300	94911.1	16.9	2832208	77616	20877.55	14.4	17156400	196800	1363.97	14.5	993716
May 21, 2007	422198000	0	55850.1	0.0	881906000	272000	18102.6	13.1	77057300	395900	94927.2	16.1	2901885	69677	20890.68	13.1	17331700	175300	1377.06	13.1	912877
May 22, 2007	422198000	0	55850.1	0.0	882202000	296000	18116.8	14.3	77172750	115450	94932.0	4.8	2978438	76553	20905.03	14.3	17522100	190400	1391.33	14.3	678403
May 23, 2007	422198000	0	55850.1	0.0	882498000	296000	18131.1	14.3	77288200	115450	94936.7	4.8	3054990	76553	20919.38	14.4	17712500	190400	1405.60	14.3	678403
May 24, 2007	422198000	0	55850.1	0.0	882812000	314000	18145.7	14.6	77308800	20600	94937.5	0.8	3133663	78673	20933.75	14.4	17913100	200600	1420.24	14.6	613873
May 25, 2007	422198000	0	55850.1	0.0	883242000	430000	18165.7	20.0	77329400	20600	94938.3	0.8	3240875	107212	20953.30	19.5	18181300	268200	1439.85	19.6	826012
May 26, 2007	422198000	0	55850.1	0.0	883603500	361500	18182.6	16.9	77454200	124800	94943.4	5.1	3332667	91792	20971.04	17.7	18409950	228650	1456.51	16.7	806742
May 27, 2007	422198000	0	55850.1	0.0	883965000	361500	18199.4	16.9	77579000	124800	94948.5	5.1	3424459	91792	20988.77	17.7	18638600	228650	1473.16	16.7	806742
May 28, 2007	422198000	0	55850.1	0.0	884275000	310000	18213.9	14.4	77690700	111700	94953.1	4.6	3502605	78146	21002.23	13.5	18837600	199000	1487.58	14.4	698846
May 29, 2007	422198000	0	55850.1	0.0	884585000	310000	18228.3	14.4	77802400	111700	94957.6	4.6	3580751	78146	21015.69	13.5	19036600	199000	1502.00	14.4	698846
May 30, 2007	422198000	0	55850.1	0.0	884910000	325000	18243.4	15.2	77899400	97000	94961.6	4.0	3664391	83640	21030.67	15.0	19250400	213800	1517.54	15.5	719440
May 31, 2007	422198000	0	55850.1	0.0	885253000	343000	18259.4	15.9	77996200	96800	94965.6	4.0	3752289	87898	21046.46	15.8	19481200	230800	1534.25	16.7	758498
Total		2000		0.2		8535000		407.4		11804400		486.5		1899531		350.6		7775100		563.5	30016031

*** Missing readings for 22, 26 and 28 May 2007 *** Data has been averaged

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
June 1, 2007	422198000	0	55850.1	0.0	885607000	354000	18275.9	16.5	78144400	148200	94971.6	6.0	3847137	94848	21063.42	17.0	19702300	221100	1550.31	16.1	818148
June 2, 2007	422198000	0	55850.1	0.0	885941000	334000	18291.4	15.6	78256200	111800	94976.2	4.6	3931514	84377	21078.60	15.2	19911600	209300	1565.52	15.2	739477
June 3, 2007	422198000	0	55850.1	0.0	886277000	336000	18307.0	15.6	78381400	125200	94981.7	5.5	4017837	86323	21094.11	15.5	20126600	215000	1581.16	15.6	762523
June 4, 2007	422198000	0	55850.1	0.0	886564000	287000	18319.7	12.6	78481100	99700	94985.3	3.6	4088238	70401	21106.77	12.7	20299500	172900	1593.77	12.6	630001
June 5, 2007	422198000	0	55850.1	0.0	886927000	363000	18337.7	18.0	78611200	130100	94990.6	5.3	4185138	96900	21124.34	17.6	20535700	236200	1611.17	17.4	826200
June 6, 2007	422211000	13000	55850.9	0.8	887288000	361000	18354.9	17.2	78726000	114800	94995.3	4.7	4277850	92712	21141.16	16.8	20752600	216900	1627.24	16.1	798412
June 7, 2007	422375000	164000	55861.2	10.3	887562000	274000	18367.9	13.0	78796700	70700	94998.2	2.9	4350555	72705	21154.23	13.1	20786600	34000	1629.74	2.5	615405
June 8, 2007	422375000	0	55861.2	0.0	887930000	368000	18385.3	17.4	78900300	103600	95002.3	4.1	4447311	96756	21171.40	17.2	21017700	231100	1646.71	17.0	799456
June 9, 2007	422375000	0	55861.2	0.0	888238000	308000	18399.8	14.5	78994800	94500	95006.2	3.9	4530128	82817	21186.00	14.6	21216100	198400	1661.21	14.5	683717
June 10, 2007	422375000	0	55861.2	0.0	888540000	302000	18414.1	14.3	79075900	81100	95009.5	3.3	4613325	83197	21200.64	14.6	21417900	201800	1675.91	14.7	668097
June 11, 2007	422376000	1000	55861.3	0.1	888805000	265000	18426.6	12.5	79145500	69600	95012.3	2.8	4685980	72655	21213.50	12.9	21595300	177400	1688.93	13.0	585655
June 12, 2007	422376000	0	55861.3	0.0	889134000	329000	18442.3	15.8	79264800	119300	95017.2	4.9	4776067	90087	21229.81	16.3	21813400	218100	1705.10	16.2	756487
June 13, 2007	422376000	0	55861.3	0.0	889487000	353000	18459.2	16.9	79415200	150400	95023.4	6.2	4873990	97923	21247.47	17.7	22053500	240100	1722.83	17.7	841423
June 14, 2007	422376000	0	55861.3	0.0	889916000	429000	18479.6	20.4	79596600	181400	95030.8	7.4	4987814	113824	21268.05	20.6	22331500	278000	1743.41	20.6	1002224
June 15, 2007	422379000	3000	55861.3	0.0	890217000	301000	18493.9	14.3	79779900	183300	95038.2	7.4	5067596	79782	21282.65	14.6	22541600	210100	1758.92	15.5	777182
June 16, 2007	422379000	0	55861.3	0.0	890666000	449000	18515.3	21.4	80311000	531100	95059.8	21.6	5189080	121484	21304.82	22.2	22830200	288600	1780.25	21.3	1390184
June 17, 2007	422391000	12000	55862.2	0.9	890998000	332000	18531.5	16.2	80692700	381700	95075.4	15.6	5273487	84407	21320.40	15.6	23047400	217200	1796.71	16.5	1027307
June 18, 2007	422391000	0	55862.2	0.0	891319000	321000	18546.8	15.3	81097200	404500	95091.8	16.4	5359857	86370	21336.15	15.8	23261600	214200	1812.51	15.8	1026070
June 19, 2007	422391000	0	55862.2	0.0	891685000	366000	18564.3	17.6	81451600	354400	95106.2	14.4	5457467	97610	21354.15	18.0	23502700	241100	1830.60	18.1	1059110
June 20, 2007	422391000	0	55862.2	0.0	892124000	439000	18585.4	21.0	81996900	545300	95128.3	22.1	5575484	118017	21375.00	20.8	23789600	286900	1852.12	21.5	1389217
June 21, 2007	422391000	0	55862.2	0.0	892439000	315000	18600.3	15.0	82366800	369900	95143.3	15.0	5660127	84643	21391.16	16.2	23996400	206800	1867.49	15.4	976343
June 22, 2007	422391000	0	55862.2	0.0	892880000	441000	18621.5	21.2	82998400	631600	95166.9	23.6	5778137	118010	21412.78	21.6	24289000	292600	1889.43	21.9	1483210
June 23, 2007	422391000	0	55862.2	0.0	893247000	367000	18639.2	17.7	83416400	418000	95185.9	19.0	5878266	100129	21431.04	18.3	24530300	241300	1907.68	18.3	1126429
June 24, 2007	422391000	0	55862.2	0.0	893588000	341000	18655.7	16.5	83917600	501200	95206.1	20.2	5968224	89958	21447.58	16.5	24747800	217500	1924.25	16.6	1149658
June 25, 2007	422391000	0	55862.2	0.0	893939000	351000	18672.5	16.8	84399900	482300	95225.7	19.6	6062602	94378	21464.68	17.1	24982500	234700	1941.88	17.6	1162378
June 26, 2007	422391000	0	55862.2	0.0	894318000	379000	18691.0	18.5	84814800	414900	95242.5	16.8	6165469	102867	21483.80	19.1	25227000	244500	1960.53	18.6	1141267
June 27, 2007	422391000	0	55862.2	0.0	894603000	285000	18708.6	17.6	85264500	449700	95260.7	18.2	6263476	98007	21501.45	17.7	25478400	251400	1979.59	19.1	1084107
June 28, 2007	422391000	0	55862.2	0.0	895118000	515000	18729.5	21.0	85838500	574000	95284.0	23.3	6381537	118061	21523.01	21.6	25762200	283800	2001.11	21.5	1490861
June 29, 2007	422391000	0	55862.2	0.0	895435000	317000	18745.0	15.5	86269300	430800	95301.4	17.4	6466855	85318	21538.77	15.8	25968900	206700	2017.07	16.0	1039818
June 30, 2007	422391000	0	55862.2	0.0	895824000	389000	18763.9	18.9	86836700	567400	95324.4	23.0	6571171	104316	21557.85	19.1	26223900	255000	2036.54	19.5	1315716
Total		193000		12.1		#######		504.5		8840500		358.8		2818882		511.4		6742700		502.3	29166082

Water Readings

Date	Well #1 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #2 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #3 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #4 Meter Reading	Gallons Pumped	Hours	Daily Hours	Well #5 Meter Reading	Gallons Pumped	Hours	Daily Hours	Total Gallons Pumped
July 1, 2007	422391000	0	55862.2	0.0	896200000	376000	18782.1	18.2	87351100	514400	95345.3	20.9	6673803	102632	21576.40	18.6	26469100	245200	2055.08	18.5	1238232
July 2, 2007	422391000	0	55862.2	0.0	896544000	344000	18798.8	16.8	87808900	457800	95364.0	18.7	6767190	93387	21593.49	17.1	26696500	227400	2072.34	17.3	1122587
July 3, 2007	422391000	0	55862.2	0.0	896919000	375000	18817.5	18.7	88298900	490000	95383.9	19.9	6870393	103203	21612.72	19.2	26941000	244500	2091.35	19.0	1212703
July 4, 2007	422391000	0	55862.2	0.0	897313000	394000	18837.1	19.6	88855100	556200	95406.6	22.7	6980454	110061	21633.28	20.6	27205100	264100	2111.88	20.5	1324361
July 5, 2007	422391000	0	55862.2	0.0	897648000	335000	18853.9	16.8	89351800	496700	95426.9	20.3	7065976	85522	21650.00	16.7	27422000	216900	2128.86	17.0	1134122
July 6, 2007	422391000	0	55862.2	0.0	897935000	287000	18868.0	14.0	89741500	389700	95442.8	15.9	7147986	82010	21664.54	14.5	27619800	197800	2143.87	15.0	956510
July 7, 2007	422391000	0	55862.2	0.0	898354000	419000	18888.7	20.8	90309500	568000	95466.1	23.3	7266145	118159	21686.32	21.8	27900700	280900	2165.52	21.7	1386059
July 8, 2007	422391000	0	55862.2	0.0	898708000	354000	18906.0	17.3	90808700	499200	95486.5	20.4	7364483	98338	21704.24	17.9	28134700	234000	2183.32	17.8	1185538
July 9, 2007	422400000	9000	55862.8	0.6	898917000	209000	18916.3	10.3	91256400	447700	95504.8	18.3	7422892	58409	21714.97	10.7	28275300	140600	2194.10	10.8	864709
July 10, 2007	422400000	0	55862.8	0.0	899163000	246000	18928.6	12.2	91717900	461500	95523.7	18.9	7493362	70470	21728.13	13.2	28445300	170000	2207.26	13.2	947970
July 11, 2007	422400000	0	55862.8	0.0	899508000	345000	18945.6	17.0	92213500	495600	95543.9	20.2	7594287	100925	21746.67	18.5	28686300	241000	2225.85	18.6	1182525
July 12, 2007	422400000	0	55862.8	0.0	899921000	413000	18965.7	20.1	92715300	501800	95564.4	20.5	7707428	113141	21766.79	20.1	28954600	268300	2246.60	20.8	1296241
July 13, 2007	422400000	0	55862.8	0.0	900248000	327000	18984.0	18.3	93126100	410800	95583.7	19.3	7810092	102664	21785.48	18.7	29166600	212000	2265.00	18.4	1052464
July 14, 2007	422436000	36000	55865.0	2.2	900675000	427000	19002.5	18.5	93593700	467600	95604.1	20.4	7915944	105852	21804.92	19.4	29385300	218700	2284.04	19.0	1255152
July 15, 2007	422436000	0	55865.0	0.0	900879000	204000	19019.5	17.0	93941000	347300	95623.9	19.8	8010540	94596	21822.41	17.5	29589300	204000	2301.53	17.5	849896
July 16, 2007	422605000	169000	55876.5	11.5	901101000	222000	19032.9	13.4	94337200	396200	95643.5	19.6	8023191	12651	21824.81	2.4	29736300	147000	2315.25	13.7	946851
July 17, 2007	422806000	201000	55890.3	13.8	901309000	208000	19045.9	13.0	94708100	370900	95661.8	18.3	8023291	100	21824.83	0.0	29879200	142900	2329.07	13.8	922900
July 18, 2007	423018000	212000	55904.9	14.6	901546000	237000	19060.6	14.7	95145900	437800	95683.6	21.8	8023894	603	21824.90	0.1	30031100	151900	2343.68	14.6	1039303
July 19, 2007	423212000	194000	55917.7	12.8	901770000	224000	19073.7	13.2	95555300	409400	95703.9	20.3	8024087	193	21824.92	0.0	30177700	146600	2357.10	13.4	974193
July 20, 2007	423440000	228000	55933.1	15.4	902014000	244000	19088.3	14.6	95936600	381300	95722.9	19.0	8024111	24	21824.92	0.0	30348100	170400	2372.92	15.8	1023724
July 21, 2007	423611000	171000	55944.5	11.4	902259000	245000	19102.7	14.4	96345600	409000	95743.2	20.3	8043178	19067	21827.34	2.4	30504800	156700	2387.21	14.3	1000767
July 22, 2007	423611000	0	55944.5	0.0	902518000	259000	19117.4	14.6	96735900	390300	95762.6	19.4	8162055	118877	21842.48	15.1	30678000	173200	2402.25	15.0	941377
July 23, 2007	423611000	0	55944.5	0.0	902763000	245000	19131.5	14.1	97126600	390700	95782.0	19.4	8272901	110846	21856.75	14.3	30841400	163400	2416.63	14.4	909946
July 24, 2007	423820000	209000	55958.8	14.3	903000000	237000	19145.9	14.5	97463500	336900	95798.7	16.7	8272921	20	21856.75	0.0	30996600	155200	2431.51	14.9	938120
July 25, 2007	424062000	242000	55975.5	16.7	903262000	262000	19162.1	16.2	97842800	379300	95817.5	18.8	8272933	12	21856.75	0.0	31175000	178400	2448.76	17.3	1061712
July 26, 2007	424291000	229000	55990.4	14.9	903534000	272000	19177.8	15.7	98241700	398900	95837.2	19.7	8365472	92539	21868.98	12.2	31209200	34200	2451.96	3.2	1026639
July 27, 2007	424498000	207000	56003.8	13.4	903770000	236000	19191.3	13.5	98611800	370100	95855.6	18.4	8476600	111128	21883.41	14.4	31209200	0	2451.96	0.0	924228
July 28, 2007	424740000	242000	56019.4	15.6	904044000	274000	19206.9	15.6	98997200	385400	95874.7	19.1	8600606	124006	21899.69	16.3	31209200	0	2451.94	0.0	1025406
July 29, 2007	424915000	175000	56030.7	11.3	904333000	289000	19223.3	16.4	99374500	377300	95893.5	18.8	8725459	124853	21916.06	16.4	31264000	54800	2456.70	4.8	1020953
July 30, 2007	424916000	1000	56030.9	0.3	904577000	244000	19236.9	13.6	99720300	345800	95910.8	17.3	8833771	108312	21929.95	13.9	31425900	161900	2470.72	14.0	861012
July 31, 2007		0		0.0		0		0.0		0		0.0		0		0.0		0		0.0	0
Total		2525000		168.7		8753000		473.0		12883600		586.4		2262600		372.1		5202000		434.2	31626200

Appendix E

Results of Tests by Eastern Analytical August - September 2007 (Bound Separately)

Appendix F

CRREL pH Results

Sampling Dates: March 2006 – September 2007

Sampling Location: Navy Pond Manhole

Results by: CRREL

pH readings for July 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
3-Jul-07	15:52	9.39	22	7.02	22	10.05	22	pHsingles	16:05	7.81	13.9	16:10	7.84	13.9		TW
5-Jul-07	14:07	9.42	23	7.01	23	10.08	23	pHsingles	14:19	7.95	14	14:24	7.97	14	*	TW
6-Jul-07	9:54	9.43	22	7.01	22	10.10	23	pHsingles	11:22	7.85	14	11:26	7.88	14		TW
9-Jul-07	8:42	9.49	20	7.02	20	10.14	21	pHsingles	9:01	7.98	14	9:06	7.98	14	*	TW
11-Jul-07	14:42	9.35	25	7.01	26	10.00	26	pHsingles	14:36	7.91	15	14:41	7.93	15	*	TW
13-Jul-07	14:07	9.43	22	7.00	22	10.10	22	pHsingles	14:26	7.85	14	14:31	7.88	14		TW
17-Jul-07	7:00	9.37	25	6.98	25	10.00	25	pHsingles	7:16	7.88	25	7:22	7.93	25		JR
18-Jul-07	6:20	9.36	25	6.99	25	10.01	25	pHsingles	6:40	7.75	25	6:48	7.85	25	*	JR
20-Jul-07	6:25	9.37	25	7.00	25	10.02	25	pHsingles	6:45	7.94	25	6:56	7.97	25		JR
23-Jul-07	14:02	9.42	23	7.03	24	10.06	24	pHsingles	14:10	7.92	13	14:19	7.95	13		TW
25-Jul-07	10:40	9.04	25	7.00	24	10.05	24	pHsingles	14:55	7.95	14	14:59	7.96	14		TW #
27-Jul-07	15:26	8.98	28	6.99	28	9.95	27	pHsingles	15:39	7.95	16	15:43	7.94	16		TW
30-Jul-07	10:14	9.11	22	7.02	22	10.11	22	pHsingles	15:52	7.98	16	12:57	7.99	16		TW

*** Check math ***

Month pH		Min	7.75	
		Max	7.99	
		Avg	7.92	
Month Temp		Max	77.00	25
		Avg	62.31	16.84

\# = Mixed up new buffer pH 9

* DID NOT COMPENSATE FOR TEMPERATURE

pH readings for May 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
2-May-07	14:55	9.11	21	7.03	21	10.08	21	pHsingles	15:10	7.86	11	15:16	7.91	11		JR
3-May-07	8:50	9.26	17	7.05	17	10.25	17	pHsingles	9:10	7.79	10	9:20	7.86	11		JR
7-May-07	15:54	9.21	21	7.04	21	10.15	21	pHsingles	16:07	7.78	13	16:12	7.79	13		TW
9-May-07	10:33	9.23	23	7.03	23	10.08	23	pHsingles	10:50	7.58	12	10:56	7.64	12		TW
10-May-07	12:53	9.22	24	7.01	25	10.03	25	pHsingles	13:37	7.84	15	13:41	7.89	14		TW
14-May-07	13:49	9.36	22	7.02	22	10.08	22	pHsingles	15:04	7.88	13	13:08	7.94	13		TW
17-May-07	14:52	9.32	22	7.03	22	10.09	22	pHsingles	15:03	7.82	11	15:07	7.86	11		TW
18-May-07	15:06	9.35	22	7.01	21	10.11	21	pHsingles	15:19	7.90	11	15:23	7.93	11		TW
21-May-07	15:26	9.39	21	7.04	21	10.13	21	pHsingles	15:37	7.68	11	15:43	7.70	11		TW
23-May-07	16:19	9.37	23	7.02	23	10.09	23	pHsingles	16:19	7.77	13	16:23	7.79	14		TW
25-May-07	7:03	9.33	23	7.02	23	10.06	23	pHsingles	7:38	7.75	12	7:43	7.75	12		TW
29-May-07	13:51	9.4	21	7.04	21	10.13	22	pHsingles	14:01	7.98	13	14:07	7.99	14		TW
31-May-07	15:33	9.42	21	7.01	21	10.13	21	pHsingles	15:44	7.84	13	15:49	7.90	13	*	TW
								Month pH		Min	7.58					
		*** Check math ***								Max	7.99					
										Avg	7.82					
								Month Temp		Max	59.00	15				
										Avg	54.02	12.23				

pH readings for April 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
4-Apr-07		9.42	19	7.02	15	10.22	17	pHsingles	14:54	7.75	11	14:59	7.81	11	*	JR
5-Apr-07		9.32	22	7.05	22	10.10	23	pHsingles	13:38	7.87	10	13:44	7.90	10	*	CG/JR
6-Apr-07		9.34	23	7.01	23	9.98	23	pHsingles	13:05	7.70	10	13:12	7.73	10		CG
9-Apr-07		9.33	23	7.00	23	10.08	23	pHsingles	13:10	8.08	10	13:16	8.09	10		JR
11-Apr-07	14:25	9.39	21	7.02	21	10.14	21	pHsingles	15:00	7.86	11	15:04	7.92	11		TW
13-Apr-07	16:12	9.4	20	7.00	20	10.14	20	pHsingles	16:29	7.90	10	16:34	7.94	11	*	TW
18-Apr-07	12:56	9.46	21	7.04	21	10.11	21	pHsingles	13:49	7.95	10	13:54	7.98	10		TW
19-Apr-07	12:32	9.41	23	7.00	23	10.06	23	pHsingles	14:10	7.96	12	14:14	7.99	12		TW
23-Apr-07	16:03	9.41	24	7.02	24	10.03	24	pHsingles	16:15	7.90	13	16:21	7.92	13		TW
25-Apr-07	12:24	9.08	21	7.00	22	10.08	22	pHsingles	12:53	7.80	11	12:57	7.86	11	*	TW
								Month pH		Min	7.70					
		*** Check math ***								Max	8.09					
										Avg	7.90					
								Month Temp		Max	55.40	13				
										Avg	51.53	10.85				

pH readings for March 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Mar-07	14:31	9.08	21	7.02	20	10.11	20	pHsingles	14:49	7.69	11	14:54	7.75	12		
6-Mar-07	16:03	9.17	20	7.07	18	10.20	19	pHsingles	16:33	7.80	10	16:38	7.84	10		
7-Mar-07	16:25	9.13	19	7.04	19	10.12	20	pHsingles	16:42	7.70	10	16:48	7.72	10		
8-Mar-07	15:29	9.13	21	7.00	21	10.08	22	pHsingles	16:09	7.72	9	16:15	7.75	9		
13-Mar-07	12:41	8.99	20	6.99	20	10.09	20	pHsingles	14:36	7.68	10	14:41	7.72	10		
15-Mar-07	15:07	9.29	20	7.04	20	10.14	20	pHsingles	15:35	7.76	10	15:39	7.82	10	*	
16-Mar-07	16:03	9.31	21	7.04	20	10.15	21	pHsingles	16:16	7.73	10	16:22	7.79	10		
19-Mar-07	12:20	9.28	21	7.01	21	10.12	21	pHsingles	16:21	7.86	10	16:25	7.91	10		
21-Mar-07	14:32	9.29	21	7.02	21	10.12	22	pHsingles	15:15	7.81	10	15:21	7.83	10		
22-Mar-07	15:44	9.29	21	7.00	22	10.08	22	pHsingles	16:07	7.69	10	16:12	7.77	10		
26-Mar-07	13:04	9.35	21	7.00	21	10.09	22	pHsingles	13:20	7.76	9	13:25	7.79	9	*	
30-Mar-07	11:59	9.39	21	7.02	20	10.15	21	pHsingles	12:26	7.68	10	12:32	7.73	10		
								Month pH		Min	7.68					
		*** Check math ***								Max	7.91					
										Avg	7.76					
								Month Temp		Max	53.60	12				
										Avg	49.93	9.96				

pH readings for February 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Feb-07	14:35	9.32	11	7.02	11	10.37	11	pHsingles	14:45	7.83	11	14:50	7.79	11		
5-Feb-07	13:05	9.36	11	7.05	11	10.39	11	pHsingles	13:34	7.93	8	13:39	7.94	8		
7-Feb-07	14:34	9.51	9	7.04	9	10.49	9	pHsingles	15:10	7.95	9	15:14	7.94	9		
8-Feb-07	15:09	9.26	10	7.05	10	10.52	10	pHsingles	16:06	7.90	8	16:11	7.91	9		
12-Feb-07	9:35	9.52	9	7.06	9	10.47	9	pHsingles	10:48	7.82	9	10:53	7.75	9		
15-Feb-07	14:52	9.48	9	7.07	9	10.46	9	pHsingles	15:08	7.80	10	15:13	7.84	10		
16-Feb-07	14:33	9.52	9	7.00	9	10.51	8	pHsingles	16:15	8.14	10	16:19	8.11	10		
20-Feb-07	11:20	9.12	14	7.06	14	10.22	15	pHsingles	12:01	7.72	11	12:06	7.74	11		
21-Feb-07	14:04	9.02	21	7.06	21	10.09	21	pHsingles	14:33	7.93	11	14:39	7.94	11		
26-Feb-07	13:15	9.14	20	7.02	19	10.19	20	pHsingles	14:07	7.72	11	14:12	7.77	11		
28-Feb-07	15:21	9.17	21	7.03	20	10.18	20	pHsingles	15:31	7.81	11	15:35	7.85	11		
								Month pH		Min	7.72					
		*** Check math ***								Max	8.14					
										Avg	7.87					
								Month Temp		Max	51.80	11				
										Avg	49.92	9.95				

7.51

pH readings for January 2007

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
2-Jan-07	10:15	9.31	11	7.02	11	10.40	11	pHsingles	10:58	7.83	10	11:04	7.82	10		
4-Jan-07	11:12	9.36	10	7.02	10	10.41	10	pHsingles	11:41	7.81	10	11:46	7.81	10		
5-Jan-07	13:56	9.42	10	7.06	10	10.45	10	pHsingles	14:20	7.83	10	14:24	7.84	10		
9-Jan-07	14:48	9.40	11	6.99	11	10.42	11	pHsingles	15:25	7.79	10	15:29	7.80	10		
10-Jan-07	19:25	9.44	10	7.04	10	10.45	10	pHsingles	16:44	7.86	10	16:50	7.88	10		
11-Jan-07	15:04	9.47	10	7.02	9	10.46	9	pHsingles	15:13	7.90	10	15:18	7.92	11		
17-Jan-07	14:41	9.34	11	7.04	10	10.44	10	pHsingles	15:02	7.78	10	15:06	7.82	10		
18-Jan-07	12:25	9.36	10	7.03	9	10.47	9	pHsingles	12:50	7.67	10	12:55	7.70	10		
19-Jan-07	14:53	9.44	11	7.05	11	10.48	10	pHsingles	15:13	7.82	10	15:17	7.84	10		
23-Jan-07	15:02	9.4	10	7.05	10	10.44	10	pHsingles	15:13	7.75	12	15:19	7.71	12		
24-Jan-07	15:32	9.31	10	6.95	10	10.47	9	pHsingles	15:45	7.72	11	15:49	7.76	11		
25-Jan-07	15:30	9.33	12	7.02	12	10.40	12	pHsingles	15:50	7.81	12	15:55	7.84	12		
29-Jan-07	15:00	9.44	9	7.06	9	10.46	9	pHsingles	15:24	7.82	10	15:30	7.83	11		
31-Jan-07	13:55	9.38	11	7.00	10	10.47	10	pHsingles	16:40	7.90	11	16:45	7.79	11		
								Month pH		Min	7.67					
			*** Check math ***							Max	7.92					
										Avg	7.81					
								Month Temp		Max	53.60	12				
										Avg	50.90	10.50				

pH readings for December 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Dec-06	12:59	9.34	15	7.03	15	10.34	14	pHsingles	13:45	7.80	11	13:49	7.79	11	*	
4-Dec-06	16:34	9.37	11	7.03	10	10.44	10	pHsingles	16:48	7.75	10	16:53	7.80	10		
5-Dec-06	15:13	9.45	11	6.97	11	10.45	11	pHsingles	15:48	7.84	10	15:54	7.83	9		
7-Dec-06	14:33	9.44	12	7.03	11	10.41	11	pHsingles	14:48	7.93	10	14:52	7.88	10		
12-Dec-06	13:45	9.43	11	7.00	10	10.48	10	pHsingles	14:02	7.70	10	14:06	7.63	10		
13-Dec-06	11:21	9.37	11	6.99	10	10.47	10	pHsingles	11:35	7.64	10	11:40	7.69	10	*	
15-Dec-06	10:35	9.29	12	7.00	12	10.43	11	pHsingles	11:15	7.93	11	11:20	7.81	11		
18-Dec-06	9:03	9.29	11	7.01	10	10.43	10	pHsingles	13:11	7.95	10	13:15	7.95	10		
20-Dec-06	14:33	9.33	11	7.05	11	10.41	10	pHsingles	14:41	7.88	10	14:45	7.78	10		
22-Dec-06	8:47	9.32	10	7.03	10	10.45	10	pHsingles	10:39	7.76	10	10:44	7.85	10		
26-Dec-06	12:36	9.27	12	6.96	12	10.41	11	pHsingles	13:21	7.70	9	13:24	7.67	9	*	
27-Dec-06	13:31	9.33	10	7.02	10	10.47	10	pHsingles	14:37	7.89	10	14:43	7.94	10		
29-Dec-06	10:40	9.44	11	6.99	11	10.44	10	pHsingles	11:14	7.95	9	11:20	7.95	9		
								Month pH		Min	7.63					
		*** Check math ***								Max	7.95					
										Avg	7.82					
								Month Temp		Max	51.80	11				
										Avg	49.93	9.96				

pH readings for November 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Nov-06	9:32	9.36	12	7.03	12	10.40	12	pHsingles	10:49	7.99	11	10:55	7.97	11		
3-Nov-06	11:31	9.39	12	7.04	11	10.43	11	pHsingles	13:45	7.83	11	13:50	7.85	11		
7-Nov-06	15:15	9.33	11	6.97	11	10.41	11	pHsingles	15:19	7.76	11	15:24	7.76	11		
8-Nov-06	14:56	9.43	11	6.99	11	10.45	10	pHsingles	15:13	7.83	10	15:17	7.79	10	*	
9-Nov-06	14:31	9.36	12	6.97	12	10.41	11	pHsingles	14:41	7.79	11	14:46	7.75	10		
14-Nov-06	13:28	9.44	11	7.05	10	10.43	10	pHsingles	13:40	7.83	11	13:44	7.86	11	*	
16-Nov-06	10:23	9.4	12	7.02	11	10.41	11	pHsingles	10:30	7.66	11	10:36	7.66	11	*	
17-Nov-06	12:36	9.37	11	7.04	11	10.42	11	pHsingles	12:52	7.85	11	12:57	7.87	11	*	
21-Nov-06	15:12	9.33	14	7.01	14	10.32	14	pHsingles	15:22	7.82	10	15:26	7.77	10		
22-Nov-06	14:30	9.31	10	7.04	10	10.29	10	pHsingles	14:40	7.84	10	14:45	7.79	10		
24-Nov-06	14:38	9.38	13	6.97	13	10.39	12	pHsingles	15:10	7.79	11	15:15	7.84	10		
27-Nov-06	15:11	9.42	11	7.02	10	10.44	10	pHsingles	15:22	7.95	10	15:26	7.95	10		
29-Nov-06	16:02	9.37	11	7.00	10	10.43	10	pHsingles	16:24	7.93	11	16:29	7.94	11		
								Month pH		Min	7.66					
		*** Check math ***								Max	7.99					
										Avg	7.83					
								Month Temp		Max	51.80	11				
										Avg	51.11	10.62				

pH readings for October 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
2-Oct-06	14:55	9.35	12	7.00	12	10.41	11	pHSingles	15:16	7.85	14	15:22	7.86	14	*	TW
4-Oct-06	11:50	9.34	12	7.04	12	10.40	12	pHSingles	12:02	7.98	13	12:06	7.98	14		TW
6-Oct-06	14:15	9.37	12	7.06	12	10.40	11	pHSingles	14:23	7.92	12	14:28	7.90	12		TW
11-Oct-06	13:21	9.38	11	7.07	11	10.42	11	pHSingles	13:27	7.93	11	13:31	7.91	11		TW
12-Oct-06	14:28	9.31	14	7.00	14	10.34	14	pHSingles	14:42	7.90	12	14:47	7.96	13	*	TW
16-Oct-06	14:57	9.43	11	7.02	11	10.44	11	pHSingles	15:10	7.95	11	15:15	7.97	11		TW
18-Oct-06	13:45	9.34	11	7.00	10	10.32	11	pHSingles	14:10	7.82	12	14:12	7.85	12		PW
20-Oct-06	12:15	9.28	11	7.02	11	10.31	11	pHSingles	12:20	7.83	11	12:25	7.81	11	*	PW
23-Oct-06	16:10	9.26	11	7.08	11	10.41	11	pHSingles	16:16	7.86	11	16:20	7.86	11	*	PW
26-Oct-06	13:06	9.43	10	7.00	10	10.45	10	pHSingles	13:21	7.91	10	13:25	7.92	10		TW
27-Oct-06	12:54	9.40	11	7.01	10	10.44	10	pHSingles	13:15	7.94	9	13:19	7.87	10		TW
30-Oct-06	12:04	9.46	12	7.09	11	10.43	11	pHSingles	15:25	7.92	10	15:29	7.88	11		TW
								Month pH		Min	7.81					
										Max	7.98					
										Avg	7.90					
								Month Temp		Max	57.20	14				
										Avg	52.70	11.50				

pH readings for September 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Sep-06	9:19	9.38	11	7.07	11	10.46	10	pHsingles	9:23	8.00	13	9:26	8.00	14		TW
5-Sep-06	8:35	9.32	13	7.07	13	10.36	13	pHsingles	8:51	8.06	14	8:55	8.09	13		TW
6-Sep-06	13:33	9.31	12	7.06	12	10.37	12	pHsingles	14:14	8.13	14	14:18	8.14	14		TW
7-Sep-06	13:40	9.34	12	7.06	12	10.38	12	pHsingles	14:09	8.15	14	14:14	8.16	13		TW
11-Sep-06	9:20	9.35	11	7.03	10	10.44	10	pHsingles	9:27	7.90	12	9:31	7.93	12		TW
13-Sep-06	10:34	9.36	11	7.03	11	10.40	11	pHsingles	11:00	7.81	12	11:04	7.80	12		TW
15-Sep-06	14:48	9.32	13	7.03	13	10.38	13	pHsingles	14:56	7.77	14	14:59	7.78	15		TW
18-Sep-06	14:26	9.29	13	7.02	13	10.38	13	pHsingles	14:48	7.88	16	14:52	7.88	16		TW
19-Sep-06	13:19	9.32	13	7.01	13	10.36	13	pHsingles	13:26	7.85	14	13:31	7.84	14		TW
21-Sep-06	9:36	9.33	13	7.03	12	10.40	12	pHsingles	9:57	7.76	11	10:02	7.77	11		TW
25-Sep-06	10:17	9.35	11	7.04	11	10.43	11	pHsingles	14:29	7.94	13	14:34	7.94	13		TW
28-Sep-06	10:18	9.37	12	7.06	11	10.42	11	pHsingles	16:00	7.98	13	16:04	7.97	13		TW
29-Sep-06	8:32	9.36	11	7.05	11	10.43	11	pHsingles	8:53	7.87	13	8:58	7.87	13		TW
								Month pH		Min	7.76					
										Max	8.16					
										Avg	7.93					
								Month Temp		Max	60.80	16				
										Avg	55.95	13.31				

pH readings for August 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
2-Aug-06	10:20	9.26	17	7.03	17	10.34	17	pHsingles	10:24	7.96	17	10:28	7.99	17		TW
4-Aug-06	13:52	9.26	15	7.03	14	10.29	15	pHsingles	14:50	7.91	15	14:54	7.93	15		TW
8-Aug-06	7:50	9.31	12	7.01	12	10.38	12	pHsingles	8:40	7.87	13	8:45	7.88	13		TW
9-Aug-06	15:11	9.29	13	6.98	13	10.33	13	pHsingles	15:22	7.88	15	15:27	7.89	15		TW
11-Aug-06	14:05	9.33	12	7.06	12	10.38	12	pHsingles	14:12	8.09	13	14:15	8.09	13		TW
14-Aug-06	13:05	9.37	12	7.10	12	10.40	12	pHsingles	14:00	8.20	14	14:05	8.21	14		TW
15-Aug-06	13:20	9.31	12	7.03	12	10.40	12	pHsingles	14:45	8.11	14	14:50	8.11	15		JR
16-Aug-06	14:40	9.29	12	7.00	12	10.28	12	pHsingles	14:55	8.05	15	15:00	8.06	15		JR
22-Aug-06	15:12	9.3	14	7.03	13	10.39	12	pHsingles	15:28	8.07	14	15:32	8.08	14		JR
23-Aug-06	14:00	9.33	12	7.05	11	10.40	11	pHsingles	14:21	8.10	13	14:25	8.08	13		TW
25-Aug-06	10:55	9.37	11	7.05	11	10.37	11	pHsingles	11:01	8.19	14	11:06	8.17	14		TW
28-Aug-06	11:15	9.35	11	7.06	11	10.43	11	pHsingles	11:34	8.11	11	11:38	8.14	11		TW
29-Aug-06	12:01	9.34	11	7.07	11	10.41	11	pHsingles	12:21	8.19	14	12:25	8.20	14		TW
31-Aug-06	15:07	9.32	13	7.07	13	10.38	13	pHsingles	15:16	8.03	14	15:20	8.06	13		TW
								Month pH		Min	7.87					
										Max	8.21					
										Avg	8.06					
								Month Temp		Max		17	62.6			
										Avg		14.28	57.706			

pH readings for July 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 9	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
2-Jul-06	13:55			6.98	19	10.17	19		14:15	7.66	16	14:21	7.71	15		JR
3-Jul-06	13:15			6.97	20	10.15	20		13:25	7.62	14	13:30	7.67	14		JR
5-Jul-06	13:30			6.99	20	10.15	20		13:53	7.69	15	13:58	7.81	15		JR
10-Jul-06	14:33			7.05	16	10.27	15		15:17	7.95	15	15:20	7.97	14		TW
12-Jul-06	14:56			6.99	21	10.14	21		15:05	7.85	15	15:08	7.88	15		TW
14-Jul-06	14:28			7.03	14	10.34	14		14:35	7.86	15	14:39	7.85	15		TW
17-Jul-06	15:02	9.25	14	7.02	15	10.28	15		15:09	7.87	17	15:13	7.89	17		TW
19-Jul-06	15:43	9.29	13	7.05	13	10.34	13		15:50	7.89	15	15:54	7.89	15		TW
21-Jul-06	14:30	9.19	14	7.04	14	10.25	14		14:40	7.86	14	14:44	7.85	14		PW
24-Jul-06	13:43	9.25	13	7.03	13	10.34	13		14:23	7.84	15	14:27	7.87	15		TW
26-Jul-06	13:30	9.23	16	7.00	15	10.32	14		13:40	7.82	16	13:45	7.83	16		TW
28-Jul-06	16:45	9.26	14	7.02	14	10.35	13		17:01	7.73	17	17:05	7.78	17		TW
31-Jul-06	10:53	9.26	13	7.04	13	10.36	13		11:16	7.87	15	11:19	7.88	15		TW
								Month pH		Min	7.62					
										Max	7.97					
										Avg	7.82					
								Month Temp		Max	17.00	62.6				
										Avg	15.23	59.42				

pH readings for June 2006																
* Denotes rain within last 24 hours																
Date	Time	pH Buffer 4	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-Jun-06	12:10			7.02	16	10.25	16		12:19	7.72	15	12:22	7.75	15		TW
5-Jun-06	14:18			6.98	12	10.36	12		15:03	7.94	13	15:06	7.94	13		TW
8-Jun-06	10:56			6.98	14	10.30	14		11:.02	7.71	12	11:08	7.75	12	*	TW
9-Jun-06	8:06			7.02	13	10.33	13		8:17	7.63	13	8:22	7.68	13	*	TW
12-Jun-06	10:07			6.96	13	10.34	12		10:12	7.68	14	10:16	7.74	14		TW
14-Jun-06	15:05			7.00	13	10.34	13		15:16	7.71	15	15:21	7.72	14	*	TW
16-Jun-06	11:13			7.00	14	10.28	14		11:37	7.82	13	11:41	7.81	13		TW
19-Jun-06	11:00			7.00	14	10.30	14		12:21	7.94	15	12:25	7.93	15		TW
20-Jun-06	13:23			6.98	14	10.32	13		13:36	7.86	15	13:40	7.89	15		TW
21-Jun-06	13:18			7.05	14	10.26	16		15:05	7.73	13	15:09	7.79	13		JR
25-Jun-06	13:05			6.98	19	10.18	19		13:15	7.70	15	13:20	7.72	15		JR
27-Jun-06	10:38			6.99	19	10.16	19		10:44	7.68	17	10:49	7.72	16		JR
28-Jun-06	13:04			6.95	21	10.13	20		13:21	7.51	18	13:26	7.64	17		JR
										100.63	188		101.08	185		
								Month pH		Min	7.51					
										Max	7.94					
										Avg	7.76					
								Month Temp		Max	18.00	64.4				
										Avg	14.35	57.823				

pH readings for May 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 4	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
1-May-06	10:25			6.97	12	10.34	12		11:04	7.71	11	11:08	7.73	11		
3-May-06	11:45			7.01	13	10.32	13		12:05	7.69	12	12:10	7.73	13		
5-May-06	15:45			6.96	12	10.33	12		15:55	7.58	12	16:02	7.65	12		
8-May-06	13:40			7.03	12	10.37	12		13:46	7.75	14	13:49	7.78	14		
10-May-06	16:05			7.01	13	10.31	13		16:15	7.71	13	16:21	7.69	12		
12-May-06	14:25			7.12	14	10.35	14		14:31	7.79	13	14:34	7.81	13	*	
18-May-06	9:20			7.00	12	10.36	12		9:33	7.73	13	9:36	7.70	13	*	
19-May-06	15:18			7.02	12	10.37	12		15:20	7.60	13	15:24	7.65	13	*	
22-May-06	15:20			7.02	12	10.37	12		15:27	7.64	12	15:31	7.68	12	*	
24-May-06	13:57			7.02	12	10.37	12		14:04	7.67	13	14:08	7.72	13		
26-May-06	8:20			7.01	13	10.35	13		8:31	7.69	12	8:35	7.75	12		
30-May-06	11:48			7.03	13	10.34	13		12:05	7.77	14	12:08	7.77	14		
31-May-06	10:48			7.02	12	10.37	12		13:44	7.81	14	13:48	7.83	14		
								Month pH		Min	7.58					
										Max	7.83					
										Avg	7.72					
								Month Temp		Max	14.00	57.2				
										Avg	12.77	54.98				

pH readings for April 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 4	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
3-Apr-06	12:20			7.02	11	10.24	11	pHSingles	13:20	7.85	11	13:24	7.88	11		
5-Apr-06	15:57			7.03	12	10.35	12	pHSingles	16:03	7.84	10	16:07	7.85	10	*	
7-Apr-06	16:30			7.03	11	10.37	11	pHSingles	16:39	7.74	10	16:43	7.69	10	*	
10-Apr-06	15:26			7.01	11	10.37	11	pHSingles	15:33	7.67	11	15:37	7.68	11		
12-Apr-06	14:05			7.02	14	10.31	14	pHSingles	14:11	7.71	13	14:15	7.76	13		
14-Apr-06	15:37			7.01	12	10.41	12	pHSingles	15:48	7.64	13	15:51	7.70	14		
17-Apr-06	12:55			7.06	13	10.37	12	pHSingles	13:05	7.77	11	13:08	7.80	11		
19-Apr-06	16:06			7.05	12	10.35	12	pHSingles	16:13	7.72	12	16:17	7.70	12		
21-Apr-06	11:45			7.03	13	10.30	13	pHSingles	11:50	7.71	12	11:55	7.70	12		
24-Apr-06	15:39			7.02	13	10.34	13	pHSingles	15:45	7.73	12	15:49	7.70	12	*	
26-Apr-06	15:30			7.02	11	10.35	11	pHSingles	15:40	7.71	12	15:43	7.70	12		
28-Apr-06	16:16			7.01	12	10.35	12	pHSingles	16:21	7.74	12	16:24	7.72	12		
								Month pH		Min	7.64					
										Max	7.88					
										Avg	7.74					
								Month Temp		Max	14.00	57.2				
										Avg	11.63	52.93				

pH readings for March 2006

* Denotes rain within last 24 hours

Date	Time	pH Buffer 4	Degrees C	pH Buffer 7	Degrees C	pH Buffer 10	Degrees C	Buffer Mix Date	Sample 1 Time	Sample 1 pH	Sample 1 Degrees C	Sample 2 Time	Sample 2 pH	Sample 2 Degrees C	Rain	Note
3-Mar-06	13:56			7.04	8	10.45	8	pHsingles	13:58	7.73	10	14:00	7.80	11		
6-Mar-06	15:43			7.06	10	10.40	10	pHsingles	15:46	7.71	11	15:49	7.74	11		
8-Mar-06	14:32			7.04	11	10.40	11	pHsingles	14:44	7.72	11	14:46	7.75	11		
9-Mar-06	15:00			7.02	11	10.38	11	pHsingles	15:15	7.81	11	15:20	7.86	11		
15-Mar-06	9:46			7.04	10	10.41	10	pHsingles	10:10	7.87	11	10:13	7.81	11		
17-Mar-06	10:03			7.03	11	10.38	11	pHsingles	10:11	7.97	10	10:14	7.98	10		
20-Mar-06	15:20			6.98	9	10.33	9	pHsingles	15:23	7.83	11	15:26	7.87	10		
22-Mar-06	16:50			6.98	11	10.34	11	pHsingles	16:52	7.70	10	16:55	7.70	11		
24-Mar-06	15:40			7.02	13	10.34	13	pHsingles	15:54	7.82	11	15:57	7.78	11		
28-Mar-06	14:20			7.02	12	10.35	12	pHsingles	14:25	7.72	11	14:27	7.72	11		
30-Mar-06	16:08			7.03	13	10.35	13	pHsingles	16:20	7.77	12	16:23	7.72	12		
31-Mar-06	14:18			7.08	13	10.37	12	pHsingles	14:22	7.63	12	14:25	7.68	12		
								Month pH		Min	7.63					
										Max	7.98					
										Avg	7.78					
								Month Temp		Max	12.00	53.6				
										Avg	10.96	51.73				

Appendix G

Data for TCE and GSF Iron and Manganese Levels 1993 - 2007

Source: CRREL

Analyses by: Others including Aquarium Analytical

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond	Extra Navy Pond	GSF IN "A"/"B"	GSF OUT	Lagoon
7/12/2007	BD	850.0	BD	4.0	BD	470.0	22.0	17.0	3.0	3.0	BD	BD			
6/13/2007	BD	950	BD	5.0	3.0	520.0	30.0	22.0	5.0	4.0	BD	BD			
5/14/2007	BD	950	BD	18.0	3.0	520.0	31.0	21.0	4.0	3.0	BD	BD			
4/19/2007	BD	900	BD	41.0	3.0	490.0	29.0	22.0	6.0	5.0	BD	BD			
3/19/2007	BD	870.0	BD	820.0	8.0	510.0	20.0	15.0	BD	4.0	BD	BD	Fe 0.52 Mn 0.078	"A" Fe 1.60 Mn 0.78 "B" Fe 0.28 Mn 0.010	
2/12/2007	BD	927.0	BD	1000.0	14.0	552.0	25.0	18.0	5.0	4.0	BD	BD			
1/18/2007	BD	942.0	BD	997.0	19.0	592.0	28.0	18.0	5.0	4.0	2.0	2.1	Fe 0.7 Mn 7.07	"A" Fe 0.8 Mn 0.03 "B" Fe 0.4 Mn BD	

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond	Extra Navy Pond	GSF IN "A"/"B"	GSF OUT	Lagoon
12/14/2006	BD	815.0	No Sample	962.0	30.0	566.0	27.0	21.0	5.0	6.0	4.0	4.0			
11/16/2006	BD	1110.0	BD	1050.0	17.0	621.0	31.0	22.0	6.0	6.0	4.0	5.0			
10/30/2006	BD	955.0	BD	991.0	22.0	Mainten.	Mainten.	784.0	77.0	66.0	29.0	30.0	Fe 1.6 Mn 0.076	"A" Fe 0.7 Mn 0.07 "B" Fe 0.5 Mn BD	
9/13/2006	4.0	1030.0	BD	974.0	3.0	642.0	35.0	24.0	7.0	6.0	3.0	7.0			
8/15/2006	58.8	971.0	BD	786.0	BD	690.0	31.2	22.0	6.5	6.6	2.1	1.8			
7/17/2006	100.0	1030.0	BD	587.0	BD	676.0	31.0	25.0	7.0	6.0	6.0		Fe 1.7 Mn 0.12	"A" Fe 0.5 Mn 0.03 "B" Fe 0.4 Mn BD	
6/15/2006	154.0	1130.0	BD	1100.0	BD	743.0	33.1	23.1	6.2	5.6	2.1	1.9			
5/18/2006	200.0	665.0	BD	690.0	BD	480.0	BD	21.0	6.0	5.0	7.0				
4/17/2006	228.0	944.0	BD	681.0	BD	695.0	33.0	27.0	8.0	5.0	3.0		Fe 0.46 Mn 0.09	"A" Fe 0.38 Mn 0.024 "B" Fe 0.29 Mn BD	
3/15/2006	108.0	290.0	BD	240.0	45.0	194.0	10.0	6.0	2.2	BD	BD				
2/14/2006	783.0	4.0	BD	354.0	BD	434.0	18.0	14.0	4.0	4.0	2.0				
1/17/2006	943.0	7.0	BD	49.0	3.0	117.0	Out- Ice	18.0	6.0	5.0	2.0		Fe 0.9 Mn 0.07	"A" Fe 1.0 Mn BD "B" Fe 0.6 Mn BD	

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN "A"/"B"	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/14/2005	365.0	8.0	BD	208	3.0	207.0	7.0	10.0	BD	BD	BD				
11/16/2005	BD	747.0	BD	908.0	49.0	539.0	25.0	17.0	5.0	18.0	4.0				
10/12/2005	BD	881.0	BD	922.0	98.0	580.0	29.0	22.0	6.0	6.0	BD	Fe	0.8	0.6	"A"
												Mn	0.087	0.024	
												Fe		0.5	"B"
												Mn		0.014	
9/14/2005	BD	1090.0	BD	1080.0	128.0	694.0	30.0	26.0	8.0	7.0	3.0				
8/15/2005	9.0	1270.0	BD	1400.0	173.0	25.0	7.0	742.0	36.0	7.0	3.0	Mislabeled?			
7/19/2005	1000.0	5.0	BD	464.0	BD	605.0	29.0	21.0	7.0	7.0	BD	Fe	0.65	0.6	"A"
												Mn	0.08	0.06	
												Fe		0.53	"B"
												Mn		BD	
6/15/2005	683.0	5.0	BD	4.0	BD	367.0	12.0	11.0	3.0	3.0	BD				
5/17/2005	537.0	6.0	BD	3.0	BD	337.0	12.0	7.0	2.0	2.0	BD				
4/28/2005															
												Fe	1.1	0.4	"A"
												Mn	0.09	0.01	
												Fe		0.4	"B"
												Mn		0.03	
4/13/2005	921.0	5.0	BD	117.0	BD	580.0	10.0	16.0	4.0	5.0	3.0				
3/15/2005	672.0	5.0	BD	376.0	BD	362.0	24.0	17.0	5.0	4.0	2.0				
2/15/2005	537.0	5.0	BD	3.0	BD	361.0	12.0	10.0	3.0	2.0	BD				
1/18/2005	524.0	7.0	BD	3.0	BD	405.0	17.0	11.0	BD	BD	BD	Fe	0.97	0.29	"A"
												Mn	0.13	0.04	
												Fe		0.13	"B"
												Mn		0.03	

TCE WATER SAMPLES

10/10/2007

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/15/2004	924.0	8.0	BD	3.0	BD	548.0	23.0	16.0	BD	2.0	BD				
11/16/2004	167.0	1370.0	BD	315.0	28.0	178.0	8.0	6.0	BD	BD	BD				
10/12/2004	207.0	9.0	BD	6.0	BD	151.0	8.0	5.0	BD	BD	BD	Fe	0.4	BD	"A"
												Mn	0.06	BD	
												Fe		0.6	"B"
												Mn		BD	
9/15/2004	BD	958.0	BD	690.0	38.0	217.0	10.0	8.0	BD	BD	BD				
8/11/2004	Repair	887.0	BD	937.0	35.0	601.0	23.0	15.0	2.0	BD	BD				
7/13/2004	262.0	192.0	BD	134.0	BD	210.0	11.0	8.0	BD	BD	BD				
5/25/2004	BD	965.0	BD	1040.0	37.0	258.0	21.0	15.0	BD	BD	BD				
4/14/2004	BD	1030.0	BD	594.0	34.0	564.0	31.0	19.0	2.0	2.0	BD				
3/16/2004	BD	1130.0	BD	765.0	42.0	604.0	34.0	24.0	3.0	3.0	2.0				
2/23/2004	BD	1270.0	BD	1260.0	42.0	715.0	24.0	20.0	3.0	6.0	3.0	Fe	0.600	0.300	"A"
												Mn	0.086	0.023	
												Fe		0.900	"B"
												Mn		0.040	
1/27/2004	82.0	27.0	BD	856.0		558.0	35.0	27.0	3.0	3.0	2.0				

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/21/2003	BD	1000.0	BD	988.0	8.0	557.0	25.0	16.0	2.0	3.0	BD				
11/11/2003	BD	791.0		23.0	2.0	379.0	17.0	26.0	BD	BD	3.0				BD
10/7/2003	BD	842.0	BD	3.0	BD	569.0	24.0	23.0	3.0	4.0	BD				BD
9/3/2003	BD	1000.0	BD	2.0		595.0	BD	19.0	BD	3.0	BD				BD
8/14/2003	BD	1630.0	BD	2.0		1030.0	52.0	48.0	BD	18.0	2.0				
7/10/2003	465.0	71.0	BD	2.0		108.0	8.0	7.0	BD	BD	BD				BD
6/12/2003	1630.0	10.0	BD	2.0	BD	987.0	41.0	33.0	BD	3.0	BD				BD
5/15/2003	263.0	1320.0	BD	3.0	BD	409.0	26.0	31.0	3.0	16.0	6.0				BD
4/17/2003	963.0	8.0		317.0	BD	516.0	30.0	23.0	BD	BD	BD				BD
3/13/2003	2280.0			BD	BD	550.0	25.0	30.0	BD	4.0	BD				
2/20/2003	6.0	11.0		3.0	BD	4.0	BD	BD	BD	BD	BD				
1/21/2003	52.0	950.0		4.0	BD	49.0	2.0	16.0	BD	BD	BD				

TCE 2002

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/19/2002	BD	1090.0		4.0	BD	78.0	7.0	24.0		13.0	8.0				
10/22/2002	45.0	696.0	BD	5.0	BD	485.0	31.0	23.0	3.0	4.0	BD				BD
9/25/2002	1420.0	7.0		8.0	BD	568.0	48.0	32.0	BD	20.0	34.0				BD
8/27/2002	787.0		BD	7.0	BD	498.0	33.0	20.0	3.0	BD	BD				BD
7/24/2002	739.0		BD	7.0		394.0	24.0	17.0	14.0	BD	BD				
6/18/2002	881.0		BD	4.0		649.0	28.0	21.0	4.0	3.0	BD				BD
5/29/2002	997.0		BD	3.0		609.0	31.0	26.0	BD	2.0	BD				BD
4/30/2002	1040.0	11.0	BD	BD	BD	700.0	38.0	28.0	BD	2.0	BD				BD
3/26/2002	985.0	11.0	BD	2.0	30.0	627.0	40.0	30.0	3.0	3.0	BD				
2/26/2002	1430.0	15.0	BD	BD	384.0	875.0	64.0	64.0	8.0	7.0	5.0				
1/29/2002	981.0	466.0	BD	BD	8.0	767.0	53.0	4.0	45.0	5.0	3.0	Fe	9.1	8.8	"A"
												Mn	0.11	0.13	
												Fe	8.1	5.3	"B"
												Mn	0.22	0.06	

TCE 2001 & 2000

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/11/2001	853.0	512.0	BD			671.0	BD		BD	5.0	BD	Fe	10	21	"A" BD
												Mn	0.16	0.16	
												Fe	10	1	"B"
												Mn	0.33	0.036	
6/14/2001	1740.0		BD	BD	BD	644.0	44.0		7.0	5.0	3.0	Fe	0.6	0.3	"A"
												Mn	0.073	BD	
												Fe	0.6	0.4	"B"
												Mn	0.076	BD	
5/8/2001	1480.0	903.0	BD	BD	BD	773.0	65.0		BD	8.0	5.0				
4/5/2001	1170.0	1140.0	BD	BD	BD	923.0	15.0		BD	10.0	5.0				
2/28/2001	2010.0	2210.0	BD	4.0	75.0	1600.0	107.0		BD	18.0	BD				
11/9/2000	1690.0	1450.0	BD	BD	BD	926.0	62.0		10.0	8.0	7.0				
10/11/2000	1520.0	1580.0	BD	4.0	BD	856.0	BD		BD	11.0	6.0				
8/29/2000	2050.0	48.0	BD	10.0	BD	776.0	BD		BD	7.0	3.0				
6/30/2000	1790.0		BD	7.0	BD	770.0	55.0		BD	8.0	4.0				
5/31/2000	1590.0		BD	8.0	BD	537.0	45.0		8.0	6.0	4.0				
5/2/2000	1840.0		BD	7.0	2.0	734.0	29.0		12.0	9.0	5.0	Fe	0.31	0.13	"A"
												Mn	0.1	BD	
												Fe	0.29	0.12	"B"
												Mn	0.1	BD	
3/21/2000	1860.0		BD	4.0	2.0	698.0	48.0		8.0	7.0	4.0				
2/25/2000	5870.0		BD	3.0	BD	953.0	BD		11.0	9.0	6.0				
2/1/2000	1440.0		BD	BD	BD	459.0	56.0		10.0	9.0	6.0				

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/28/1999	712.0	1090.0	5?	BD	BD	505.0	44.0		BD	9.0	5.0	Fe	0.45	0.13	
												Mn	0.11	BD	
												Fe	0.43	0.15	"B"
												Mn	0.11	0.002	
11/30/1999	1630.0	764.0	BD	BD	BD	757.0	49.0		11.0	12.0	6.0				
10/26/1999	1370.0	1230.0	BD	BD	BD	736.0	36.0		14.0	27.0	10.0	Fe	0.33	0.1	"A"
												Mn	0.18	0.006	
												Fe	0.51	0.17	"B"
												Mn	0.17	0.046	
6/30/1999	1700.0	1960.0	BD		2.0	1180.0	70.0		15.0	7.0	BD	Fe	0.41	0.17	"A"
												Mn	0.2	0	
												Fe	0.37	0.17	"B"
												Mn	0.18	0.001	
6/1/1999	1920.0	1780.0	BD		3.0	1120.0	34.0		21.0	8.0	BD	Fe	0.42	0.17	"A"
												Mn	0.19	0.005	
												Fe	0.45	0.16	"B"
												Mn	0.19	0.003	
4/30/1999	1220.0	2980.0	BD		2.0	492.0	21.0		3.0	BD	BD	Fe	0.37	0.16	"A"
												Mn	0.35	0.14	
												Fe	0.36	0.15	"B"
												Mn	0.35	0.14	
3/31/1999	837.0	2536.0	BD	8.0	BD	940.0	62.0		8.0	BD	BD	Fe	0.48	0.23	"A"
												Mn	0.3	0.1	
												Fe	0.56	0.22	"B"
												Mn	0.4	0.2	
2/26/1999	623.0	2740.0	BD	BD	2.0	717.0	95.0		14.0	6.6	BD	Fe	0.53	0.2	"A"
												Mn	0.16	0.11	
												Fe	0.61	0.19	"B"
												Mn	0.2	0.09	
2/2/1999	637.0	3850.0	BD	12.0	2.0	1310.0	67.0		11.0	4.6	3.8	Fe	1	0.73	"A"
												Mn	0.38	0.15	
												Fe	0.96	0.81	"B"
												Mn	0.37	0.17	

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/30/1998	566.0	4580.0	BD	13.0	BD	692.0	28.0		5.5	BD	BD	Fe	0.78	0.31	"A"
												Mn	0.8	0.29	
												Fe	0.67	0.33	"B"
												Mn	0.78	0.33	
11/30/1998	201.0	2200.0	BD	5.5	BD	913.0	45.0		8.0	3.4	BD				
10/29/1998	311.0	2540.0	BD	7.3	BD	183.0	7.3		9.0	BD	BD				
10/5/1998	219.0	3100.0	BD	7.8	3.0	865.0	58.0		BD	8.4	2.9				
8/31/1998	1360.0	3400.0	BD	1250.0	2.0	1410.0	98.0		15.0	13.0	4.0				
7/30/1998	-	3760.0	BD	6.2	6.4	1440.0	92.0		BD	15.0	3.0				
6/26/1998	457.0	230.0	BD	6.0	BD	132.0	11.0		BD	BD	BD				
5/28/1998	210.0	2790.0	BD	6.0	BD	1230.0	BD		BD	9.3	4.7				
4/27/1998	366.0	2770.0	BD	4.0	BD	1270.0	BD		16.0	14.0	8.0				
3/27/1998	1330.0	4770.0	BD	BD	2.0	2140.0	208.0		48.0	38.7	25.6				
2/26/1998	1100.0	3480.0	BD	19.0	BD	1400.0	76.3		5.2	44.0	28.0				
1/27/1998	870.0	744.0	BD	15.7	BD	543.0	16.4		2.3	85.1	48.0				

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
11/24/1997	1010.0	-	BD	14.0	-	942.0	30.0		4.2	BD	5.0				
10/27/1997	1590	63.5	BD	9.1	2.1	346	59.8		10.1	8.1	4.3				
9/29/1997	1730.0	580.0	BD	12.0	2.0	702.0	BD		BD	11.0	6.0				
8/29/1997	1630.0	92.0	BD	12.0	3.0	725.0	BD		67.0	10.0	5.9				
7/29/1997	1400.0	40.0	BD	11.0	2.0	716.0	58.0		BD	7.0	2.0				
6/26/1997	1160.0	396.0	BD	11.0	BD	769.0	33.0		9.1	8.0	3.3				
5/29/1997	1180.0	160.0	BD	7.2	2.5	478.0	72.9		94.6	70.5	39.4	Blower #2 Off			
4/22/1997	2030.0	255.0	BD	BD	3.1	1250.0	581.0		180	206.0	84.8	Blower #1 Off			
3/28/1997	1710.0	605.0	BD	4.3	3.9	925.0	926.0		45.0	50.3	22.7	Blower #1 Off			
2/25/1997	1090.0	2840.0	BD	3.3	1.9	582.0	36.7		20.8	53.2	16.1				
1/28/1997	2550.0	592.0	BD	BD	6.0	931.0	38.0		60.7	182.0	95.9				

TCE 1996

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/26/1996	1650.0	1160.0	BD	1.7	4.8	944.0	92.3		6.5	5.9	5	Fe	0.23	BD	
												Mn	0.07	0.03	
11/21/1996	827.0	2510.0	BD	5.8	2.7	107.0	32.2		1.9	4.0	2.5	Fe	0.03		
												Mn	0.17		
10/25/1996	775.0	216.0	BD	BD	6.4	402.0	20.7		2.7	7.8	4.9				
9/24/1996	840.0	208.0	BD	8.0	7.1	546.0	38.0		9.1	12.0	5.9				
8/27/1996	496.0	BD	BD	30.7	7.0	282.0	22.0		3.7	3.3	BD				
7/29/1996	242.0	-	BD	5.2	-	124.0	5.0		16.7	10.3	3.2	Fe	0.085	BD	
												Mn	0.062	BD	
6/26/1996	273.0	1700.0	BD	8.7	-	877.0	BD		10.9	12.2	4.7				
5/28/1996	140.0	1810.0	BD	7.2	-	923.0	114.0		13.7	84.4	19.8				
4/25/1996	25.5	1530.0	BD	3.9	4.3	646.0	78.6		8.1	7.6	2.0				
3/25/1996	7.7	1120.0	BD	3.3	3.8	495.0	BD		3.6	4.2	BD	Fe	0.274	0.527	
												Mn	0.080	0.007	
2/26/1996	695.0	1800.0	BD	2.6	2.7	999.0	45.2		BD	35.0	11.0				
1/25/1996	8.2	1980.0	BD	2.5	13.1	58.1	20.9		4.4	4.7	2.9				

TCE 1995

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/27/1995	412.0	2140.0	BD	3.2	5.0	750.0	41.0		BD	8.9	2.9				
11/20/1995	648.0	33.6	BD	14.9	9.1	395.0	16.6		2.1	1.9	BD	Fe	0.2600	BD	
												Mn	0.1480	BD	
10/23/1995	359.0	1940.0	NS	BD	2.8	802.0	58.5		43.1	32.1	23.0				
9/27/1995	101.0	1880.0	BD	BD	4.8	981.0	BD		32.1	28.7	21.7				
8/28/1995	462.0	1930.0	BD	2.5	3.8	1660.0	136.0		136.0	32.8	17.0	Fe	0.207	0.102	
												Mn	0.030	BD	
7/27/1995	739.0	374.0	BD	2.8	5.6	634.0	17.7		NS	33.2	14.7				
6/30/1995	46.8	1900.0	BD	BD	4.4	799.0	42.6		22.0	36.3	16.1				
6/23/1995												Fe	BD	BD	
												Mn	BD	BD	
6/1/1995	34.2	2050.0	BD	BD	29.7	1240.0	64.4		BD	6.6	4.0		RCRA Metals done		
2/28/1995	NS	1750.0	BD	9.9	65.0	915.0	47.0		7.9	6.4	2.5	Fe	0.346	0.108	
												Mn	0.053	<0.010	
1/23/1995	1610.0	22.6	BD	10.3	8.8	471.0	34.6		5.0	4.9	2.1	Fe	0.312	<0.010	
												Mn	0.084	<0.010	

TCE 1994 & 1993

DATE	#1 DW	#2 DW	#3 DW	#4 DW	#5 DW	Tow1 IN	RES. #1 Tow1 Out	Tow2 IN	RES. #2 Tow2 Out	Exist. Res.	Navy Pond		GSF IN	GSF OUT	Lagoon
	ppb	ppb	ppb	ppb	ppb	ppb	ppb		ppb	ppb	ppb		ppm	ppm	
12/30/1994	1520.0	NS	BD	3.5	6.5	942.0	50.5		7.3	5.6	BD	Fe	0.091	<0.010	
												Mn	0.055	<0.010	
9/27/1994	NS	2210.0	BD	36.7	252.0	1110.0	54.0		3.6	6.7	3.4	Fe		0.017	
												Mn		0.021	
8/29/1994	1450.0	19.5	BD	38.5	8.2	778.0	54.7		6.1	5.7	5.0	Fe		<0.010	
7/29/1994	1250.0	19.1	BD	9.3	6.6	674.0	51.4		7.9	7.5	4.1	Fe	0.046	<0.010	
												Mn	0.205	<0.010	
6/30/1994	1690.0	24.7	BD	445.0	5.9	681.0	50.8			7.2	4.5	Fe		<0.010	
												Mn		<0.014	
5/94	1930.0	NS	BD	4.6	8.1		95.0		19.1	20.2	9.5	Fe		0.019	
												Mn		0.089	
3/22/1994						331.0	BD		37.4	42.2					
3/15/1994	416.0	226.0	BD	113.0	8.0	354.0	BD			41.1	27.0				
2/28/1994	NS	2930.0	BD	NS	14.3	737.0	9.5			107.0	67.1	Permanent TCE Plant			
1/24/1994	1020.0	NS	BD	5.2	NS	1060.0				101.0	41.4				
11/5/1993	1040.0	NS	BD	NS	NS	1070.0				3.9	18.8	Carbon Tower: No TCE			
10/9/1993	19.8	NS	BD	5.5	NS	19.1				BD	3.6				
9/15/1995	876.0	83.2	BD	8.6	11.0	736.0				13.4	7.6				
8/13/1993	1470.0	39.9	BD	3.5	9.0	38.1				6.5					
7/93	211.0	800.0	BD	2.5	7.3	169.0				BD					
6/93	NS	1730.0	BD	BD	BD	1620.0				6.7					

Appendix H

CRREL's pH Investigation Results
September 1, 2006

pH readings for 1 September 2006

Well Pump # 1 and Well Pump # 2 in Auto and P-7 on for FERF
IEF is offline - P-8's turned off at 9 am on 31 August 2006

Sample location

Sample #	Date and	Time	pH rdg	Temp. Degrees C
Deep Well 1				
#1	9/1/06	10:41	7.74	9
#2	9/1/06	10:43	7.73	9
Deep Well 2				
#1	9/1/06	10:28	7.87	9
#2	9/1/06	10:31	7.84	9
Tower 1 IN				
#1	9/1/06	10:51	7.77	9
#2	9/1/06	10:53	7.75	9
Tower 1 OUT				
#1	9/1/06	10:55	8.25	10
#2	9/1/06	10:59	8.27	10
Tower 2 IN				
#1	9/1/06	11:04	8.01	10
#2	9/1/06	11:07	8.05	10
Tower 2 OUT				
#1	9/1/06	11:09	8.26	10
#2	9/1/06	11:12	8.26	10
Main Lab Res				
#1	9/1/06	10:07	7.73	10
#2	9/1/06	10:12	7.69	10

Appendix I

Excerpt from January 2006 Toxicity Report

from toxicity report

TABLE 5. Summary of Daily Water Quality Data.USA CRREL Effluent Evaluation. January 2006.

PARAMETER	UNITS		EFFLUENT	RECEIVING WATER
Alkalinity	mg/L	Day 0	150	20
		Day 2	160	26
		Day 4	150	<10
Hardness	mg/L	Day 0	210	26
		Day 2	250	32
		Day 4	220	33
Specific Conductance	µmhos/cm	Day 0	654	117
		Day 2	635	119
		Day 4	611	100
pH	SU	Day 0	7.83	7.24
		Day 2	7.84	6.96
		Day 4	7.79	6.99
Total Residual Chlorine	mg/L	Day 0	<0.05	<0.05
		Day 2	<0.05	<0.05
		Day 4	<0.05	<0.05
Total Solids	mg/L	Day 0	270	14
Total Suspended Solids	mg/L	Day 0	<10	10
Ammonia	mg/L	Day 0	<0.1	<0.1
Total Organic Carbon	mg/L	Day 0	0.5	3.7
Aluminum, total	mg/L	Day 0	<0.01	0.098
Cadmium, total	mg/L	Day 0	<0.001	-
Calcium, total	mg/L	Day 0	77	8.6
Chromium, total	mg/L	Day 0	0.003	-
Copper, total	mg/L	Day 0	0.006	0.005
Lead, total	mg/L	Day 0	0.008	<0.005
Magnesium, total	mg/L	Day 0	8.9	0.98
Nickel, total	mg/L	Day 0	0.006	0.005
Zinc, total	mg/L	Day 0	0.017	0.015

Appendix J

CRREL's pH Investigation Results
June 8, 2005

pH samples from 8 June 2005

Well Pumps # 1 & # 4 running during Tower sampling

Location	Smpl#1Time	#1pH	#1DegC	#2Time	#2pH	#2DegC
Deep Well # 1	8:27	7.64	10	8:30	7.68	9
Deep Well # 2	9:24	7.74	10	9:26	7.73	10
Deep Well # 3	8:09	7.77	10	8:11	7.77	10
Deep Well # 4	8:21	7.70	10	8:23	7.68	10
Deep Well # 5	9:29	7.85	9	9:31	7.87	9
Tower # 1 In	8:34	7.65	10	8:36	7.68	10
Tower # 1 Out	8:59	8.10	10	9:01	8.11	10
Tower # 2 In	8:48	7.71	11	8:50	7.88	11
Tower # 2 Out	8:53	8.10	11	8:56	8.11	11
Existing Reservoir	10:10	7.54	11	10:12	7.55	11
Navy Pond	7:54	7.90	14	7:56	7.91	14

Appendix K

T&M Associates June 1995 Water Quality Tests

CO_2 Sampling 6/29

T&M Associates, Inc. Engineers & Surveyors
HCR 63, Box 9A Route 4
Lebanon, New Hampshire 03766
(603) 448-1295, FAX:(603)448-2965

Subject Sampling
Project CRREL
Project No. ~~3953~~/894
Scale ______ Date 6/29/95 By ADA

Location	pH	Alkalinity (mg/l)	Calcium (Total) (mg/l)	T
Bag Filter	7.35	161	68	13.4°C
Facility Discharge STORM BASIN	7.54	159	67	16.4°C
Existing Reservoir	7.21	157	67	14.2°C
Tower 2 Effluent	8.17	143	69	12.0°C

WELLS 1 & 2

Appendix L

Investigation of Scaling In Heat Exchanger System Piping
March 21, 1995

DRAFT

Investigation of Scaling In Heat Exchanger System Piping

For

United States Army

Cold Regions Research And Engineering Laboratory

March 21, 1995

Objective:

The objective of this work was to determine the cause of scaling of the CRREL once through cooling water heat exchanger system piping; and recommend corrective measures.

Background:

This scaling problem was observed to have occurred after the new iron and manganese removal and volatile organic carbon (VOC) removal groundwater treatment systems were placed into service. Prior to that time, without the groundwater treatment system, a gelatinous reddish orange slime-like residue was found in process piping during routine maintenance. The scale that is observed now is very hard, white, and crystalline. There is a slight coating of brownish residue on the surface of the scale.

The new groundwater treatment processes were designed by Metcalf & Eddy, Inc. and are composed of manganese greensand filtration followed by volatile organic carbon (VOC) packed tower air striping. There are two greensand filters in parallel with continuous permanganate feed; followed by two packed towers in series. The permanganate is the only chemical added to the processes. Water from wet well 2 under stripping tower 2 is pumped up to an old existing concrete in-ground reservoir. Water from the reservoir is pumped into the heat exchange systems after passing through a cartridge filtration system. Before the final facility was completed, packed tower stripping alone was used for about 1 year; and during this time the white, crystalline scale was not noted.

Findings:

Monthly operations reports by T & M Associates, Inc. and water quality data from 11/18/94 were initially examined. A site visit by L. VandeVenter and J. Madden took place on 1/5/95 and a meeting was held with CRREL staff and Mr. Dana Arey of T&M Associates to review the history of the problem and plant operations.

During the site visit L. VandeVenter exposed a portion of residue from a PVC pipe to a few drops of concentrated hydrochloric acid. The effervescence and neutralization of the HCl indicated a likelihood that the residue was primarily calcium carbonate rather that calcium sulfate.

Solubility calculations using raw groundwater calcium and sulfate values of 63 and 31 mg/L as ions were performed to determine if calcium sulfate could be precipitating. These calculations indicated that calcium sulfate should remain soluble up to a temperature of 150°C and therefore would not contribute to scaling of process piping under expected plant operating conditions.

The water quality data from 11/18/94 was not very useful for evaluation of this problem because the analyses were not in ionic balance (+/- 20% deviation) when expressed as calcium carbonate and could not be trusted completely. An ionic balance of +/- 5% would be considered an acceptable analysis.

Our preliminary findings are summarized in an internal memorandum (attached), in which we discuss our questions about the former data, the preliminary conclusions about the composition of the residue, and the recommendations for additional sampling.

In order to quantify the degree of calcium carbonate scaling potential a very precise analysis of the water as it moves through the treatment processes is required. M&E recommended in the meeting of 1/5/95 that a complete round of sampling be performed again coupled with on-site pH and temperature measurements. This sampling was conducted on January 23, 1995. Samples were collected and field measurements performed by Mr. Dana Arey of T&M Associates, Inc. All samples were analyzed by ChemServe. Immediate analysis of alkalinity was performed.

Results for this round of sampling are summarized in Table I. Wells 2 and 5 were operating during this sampling event and permanganate was being used. In this table the results are reported both as ion concentrations and as calcium carbonate equivalent concentrations. When expressed as calcium carbonate equivalents the total of cations and anions should be equal or in balance. It is immediately apparent that the ionic balance is < 5% in all cases except one which is 6.58% for the cooling water effluent sample. A positive value indicates that cations were greater in concentration than anions. A negative value indicates that the anions were greater. Thus these water analyses are within acceptable limits and can be used in the assessment of this scaling problem.

Several things should be noted in this data. The calcium values should not change significantly across the process sequence and with the exception of the reservoir effluent sample it is the same in all samples. This may be due to analytical error in the inductively coupled plasma (ICP) analysis of individual calcium ion, because total hardness (Ca + Mg) analytical data is constant across the processes. Calculated total hardness values using the individual Ca and Mg values would of course show a deviation. Magnesium, sodium, potassium, total hardness (analytical), chloride, sulfate, silicon, values are unchanged across the process. Alkalinity values are in line with past historical levels. There is a slight decrease in alkalinity in the reservoir effluent and cooling water effluent samples. The pH starts at 7.62 in the raw groundwater and increases very slightly through the greensand filters to 7.81; rises significantly to about pH 8.5 in the tower wet wells; stays in the pH 8.4 level through the reservoir; and drops slightly again through the cooling water sample. Temperature starts at 9.3°C in raw groundwater and through the greensand filters; drops to 6.6°C in the tower 2 wet well; drops to a low of 5.6°C in the reservoir; and rises to 10.3°C in the reservoir effluent and to 18.9°C in the cooling water effluent after the heat exchanger. Packed tower aeration in the winter would be expected to decrease the water temperature in this fashion. Turbidity is low in the raw groundwater and less than 0.5 NTU across the processes. Color was 0 PCU in all samples. Total iron of the raw groundwater was 0.346 ppm; 0.108 ppm in the greensand filter effluent; and less than 0.012 ppm across the remaining processes. Total manganese was 0.053 ppm in the raw groundwater and less than 0.010 ppm in the greensand filter effluent and beyond. Total organic carbon is low at 1.0 ppm in the groundwater and through all of the processes. Soluble iron was less than the detection limit in all samples except the tower 1 wet well but the 0.012 ppm detected may not be analytically significant. Soluble manganese was 0.049 ppm in raw groundwater and less than 0.010 ppm in greensand filter effluent and beyond. There are both an analytical total dissolved solids (TDS) and a calculated value which we computed from the water analysis constituents and there is fairly good agreement in these numbers.

We took the data for pH, alkalinity, TDS (calc.), and T°C for each sample and used a nomographic technique (American Public Health Association Standard Methods For The Examination of Water and Wastewater, 18th. Edition, section 4-16 figure 4500 CO_2) to determine the free carbon dioxide level. This revealed that there is about 8 ppm free CO_2 in the raw groundwater. This decreased to about 5 ppm through the greensand filter; decreased to about 1 ppm after the packed towers; and remained less than 2 ppm through the subsequent samples. This decrease in free CO_2 corresponds to the observed increase in pH through the towers.

We next calculated the Langlier Saturation Index (LSI) for each water sample. A positive value would indicate precipitation of calcium carbonate; a negative value indicates that calcium carbonate would dissolve; and a zero value indicates that the water would be in stable equilibrium with calcium carbonate. This data indicates that the raw groundwater is only very slightly aggressive to calcium carbonate (unstable). After the greensand filters this instability moved more toward zero (more stable). After the packed towers the stability shifted to slightly precipitating calcium carbonate; indicating a slight scale forming tendency.

To determine the mg/L of calcium carbonate precipitation potential (CCPP) we used the Rothberg, Tamburini, and Windsor Model (RTW) which is based on the Caldwell-Lawrence (CL) analysis of calcium carbonate stability (Table I). This model calculates the LSI, Ryznar Index, and CCPP. The LSI values are about the same and show the same trend as our manual calculations. The Ryznar Index is a method of quantifying the scale forming or corrosive effect of water. It is based on the pH of the water and the water's pH of saturation with respect to calcium carbonate. Ryznar values above 6 are progressively corrosive; and values below 6 are progressively scale forming. However this is not an absolute science and often LSI and Ryznar values fail to predict corrosive or scale forming tendencies correctly. Here it appears that the LSIs predicts that the tower wet well samples are slightly scale forming, while the Ryznar Index predicts that the water is still slightly corrosive. The CCPP values based on the CL analysis shed additional light on the problem. The CCPP is less than zero in the raw groundwater; the greensand effluent is 4.87 mg/L calcium carbonate ($CaCO_3$); the tower wet well samples are about 13 mg/L; and the remaining process points are in the range of 10-12 mg/L as $CaCO_3$. These values represent the relative amount of calcium carbonate which could precipitate under the conditions of temperature, pH, alkalinity, calcium, and TDS. In routine, potable water, lime softening applications, it is customary to reduce the scaling potential of the softened water by recarbonating with CO_2 to decrease the pH. In that case the goal is a CCPP value of between 4-10 mg/L for the water entering the distribution system. This will lay down a slight calcium carbonate scale on distribution pipe surfaces and prevent corrosion. It is apparent in this situation that the CCPP is greater than 10 mg/L in the tower wet well samples and through the subsequent process points. It may be that the reservoir, reservoir effluent, and cooling water effluent samples are slightly lower in CCPP due to the fact that scaling is occurring.

The RTW model can also be used to input chemical changes and determine the end results expected. We took the tower wet well sample data and "titrated" it with either CO_2 or sulfuric acid to reduce the CCPP to near zero. This data is also shown in Table I. It appears that about 8 mg/L of either CO_2 or sulfuric acid would accomplish this. Corresponding LSI and Ryznar index changes are also shown in the table.

The affect of increased ambient air temperature during summer, which will correspondingly increase water temperature in the packed towers was also considered and modeled with the RTW. This increased the CCPP of the water and required a higher dosage of pH adjustment chemical to correct.

Conclusions:

1. There appears to be a small amount of free CO_2 in the raw groundwater.

2. The packed towers are removing this CO_2; causing an increase in pH; and shifting the calcium carbonate precipitation potential to a slightly scale forming condition.

3. Under these conditions the scale would be expected to be primarily composed of calcium carbonate; as it appears to be.

4. This is the most likely explanation for the scaling which has been observed in the heat exchanger system process piping.

5. Phosphate based sequesterants could be used to reduce this scaling tendency but a major draw back would be the phosphate residual which would remain in the cooling water discharged to the Connecticut River.

6. A more effective method of control would be to adjust the pH with either CO_2 or sulfuric acid.

7. Preliminary estimates indicate that about 8 ppm of CO_2 would be required to accomplish the desired level of pH adjustment in the groundwater combination being processed at the time of sampling on January 23, 1995. This value may be different with different combinations of groundwater.

Recommendations:

1. Perform field analyses to confirm the presence of free CO_2 in raw groundwaters, and throughout the unit processes.

2. Perform field titrations with sulfuric acid to confirm the dosage required to reduce the pH of packed tower wet well water to target levels for calcium carbonate stability.

3. Examine the groundwater treatment system to determine the best application point for the pH adjustment. Determine the best location for the pH adjustment chemical feed system.

4. Evaluate the handling requirements and equipment required to feed either CO_2 or sulfuric acid. CO_2 is probably a better choice due to safety and ease of handling.

5. Based upon raw groundwater CO_2 concentrations, estimate the amount of CO_2 required for pH adjustment.

6. Consider and evaluate using an eductor to inject CO_2 on the discharge side of the wet well transfer pumps. Determine if an in-line static mixer would also be recommended.

7. Determine the impact of warmer ambient air temperatures (Summer) on CCPP after packed tower air stripping, using worst case data for expected or known water temperatures.

8. Refine the range of pH adjustment chemical dosages expected to be required for desired blends of groundwater, and at expected minimum, average, and maximum flow rates.

9. Determine how the pH adjustment chemical will be paced to flow and trimmed on pH.

10. Determine how the start-stop cycling of the groundwater treatment system could be smoothed out for a more constant flow operation.

11. Install corrosion monitoring coupons in strategic locations in process piping so that the potential of corrosion and scaling can be monitored.

12. Consider setting up a temporary system for pH adjustment to confirm the process chemistry prior to finalizing the design.

Table I
CRREL
Laboratory Results
Sampling Date: January 23, 1995

Parameter	Raw Groundwater As Ion	Raw Groundwater As CaCO3	Greensand Effluent As Ion	Greensand Effluent As CaCO3	Tower Wet Well 1 As Ion	Tower Wet Well 1 As CaCO3	Tower Wet Well 2 As Ion	Tower Wet Well 2 As CaCO3
Calcium	61.94	155	61.40	153.50	61.40	154	62.02	155
Magnesium	7.06	29	7.00	28.84	7.00	29	7.15	29
Sodium	17.4	38	17.0	37	16.9	37	17.2	37
Potassium	4.57	6	4.73	6	4.65	6	4.69	6
Total Hardness	--	207	--	205	--	205	--	205
Total Hardness (calc)	--	184	--	182	--	182	--	185
Total Cations	--	228	--	225	--	225	--	228
P-Alkalinity	--	0	--	0	--	0	--	0
M-Alkalinity	--	139	--	142	--	144	--	139
Bicarbonate	170	--	173	--	176	--	170	--
Chloride	<3	0	<3	0	<3	0	<3	0
Sulfate	31	32	30	31	30	31	30	31
Silicon	5.59	40	5.56	40	5.54	40	5.56	40
Fluoride	<0.10	0	<0.10	0	<0.10	0	<0.10	0
Nitrate	<1.0	0	<1.0	0	<1.0	0	<1.0	0
Total Anions	--	211	--	213	--	215	--	210
pH	7.62	--	7.81	--	8.5	--	8.48	--
Temperature (deg. C)	9.3	--	9.30	--	6.8	--	6.6	--
Turbidity (NTU)	1.3	--	<0.5	--	<0.5	--	<0.5	--
Color	0	--	0	--	0	--	0	--
Iron -- Total	0.348	--	0.108	--	0.111	--	0.112	--
Iron -- Soluble	<0.010	--	<0.010	--	0.012	--	<0.010	--
Manganese -- Total	0.053	--	<0.010	--	<0.010	--	<0.010	--
Manganese -- Soluble	0.043	--	<0.010	--	<0.010	--	<0.010	--
TOC	1	--	1	--	1	--	1	--
CaCO3 Balance (%)	--	3.77	--	2.86	--	2.36	--	4.14
TDS	300	--	277	--	295	--	277	--
TDS (Calc)	297	--	299	--	301	--	296	--
CO2*	8	--	5.4	--	1 2	--	1.2	--
LSI**	-0.27	--	-0.06	--	0.61	--	0.58	--
RTW Model Results								
LSI**	-0.02		0.18		0.63		0.8	
Ryznar	7.67		7.46		6.84		6.88	
CCPP+	-0.11		4.87		13.58		13.08	
CO2 Dosage					8		7.5	
LSI					0		0	
Ryznar					7.67		7.68	
CCPP+					-0.08		-0.11	
pH					7.67		7.68	
Sulfuric Acid Dosage					6		7.5	
LSI					0		-0.01	
Ryznar					7.69		7.71	
CCPP+					-0.12		-0.14	
pH					7.70		7.70	

Parameter	Reservoir As Ion	Reservoir As CaCO3	Reservoir Effluent As Ion	Reservoir Effluent As CaCO3	Cooling Water Effluent As Ion	Cooling Water Effluent As CaCO3
Calcium	61.84	155	51.76	129	61.75	154
Magnesium	7.15	29	7.11	29	7.14	29
Sodium	17.3	38	17.2	37	17.4	38
Potassium	4.73	6	4.75	6	4.77	6
Total Hardness	--	205	--	207	--	205
Total Hardness (calc)	--	184	--	159	--	184
Total Cations	--	228	--	202	--	228
P-Alkalinity	--	0	--	0	--	0
M-Alkalinity	--	139	--	129	--	126
Bicarbonate	170	--	157	--	154	--
Chloride	<3	0	<3	0	<3	0
Sulfate	32	33	32	33	32	33
Silicon	5.66	40	5.61	40	5.66	40
Fluoride	<0.10	0	<0.10	0	<0.10	0
Nitrate	<1.0	0	<1.0	0	<1.0	0
Total Anions	--	213	--	202	--	200
pH	8.49	--	8.42	--	8.19	--
Temperature (deg. C)	5.8	--	10.3	--	18.9	--
Turbidity (NTU)	<0.5	--	<0.5	--	<0.5	--
Color	0	--	0	--	0	--
Iron -- Total	0.110	--	0.108	--	0.096	--
Iron -- Soluble	<0.010	--	<0.010	--	<0.010	--
Manganese -- Total	<0.010	--	<0.010	--	<0.010	--
Manganese -- Soluble	<0.010	--	<0.010	--	<0.010	--
TOC	1	--	1	--	1	--
CaCO3 Balance (%)	--	3.44	--	-0.02	--	6.58
TDS	294	--	296	--	212	--
TDS (Calc)	298	--	276	--	282	--
CO2*	1.4	--	1.1	--	1.6	--
LSI**	0.59	--	0.41	--	0.26	--
RTW Model Results						
LSI**	0.73		0.66		0.67 70	
Ryznar	6.98		7.06		6.84 76	
CCPP+	12.39		10.15		11.78 710	
CO2 Dosage						
LSI						
Ryznar						
CCPP+						
pH						
Sulfuric Acid Dosage						
LSI						
Ryznar						
CCPP+						
pH						

* Nomographically determined
** Uses TDS laboratory value
\+ CCPP -- Calcium Carbonate Precipitation Potential

Appendix M

Excerpt from 1995 TCE Groundwater Treatment Facility Contract Documents

TABLE 1
CHEMICAL CONCENTRATIONS OF INFLUENT GROUNDWATER

Well No.	pH Max.	pH Min.	Total Hardness (mg/l)	Iron (mg/l) Max.	Iron (mg/l) Min.	Manganese (mg/l) Max.	Manganese (mg/l) Min.	Total Alkalinity (mg/l)	Sulfate (mg/l)	Nitrate (mg/l)	TCE ()g/l) Max.	TCE ()g/l) Min.
1	7.7	7.2	183	0.49	0.22	0.11	0.06	128	31	0.20	1012	137
2	7.7	7.0	200	0.76	0.38	0.12	0.04	148	43	0.09	3800	43
4	7.7	7.2	185	0.87	0.25	0.10	0.06	134	35	0.76	21	nd*
5	7.7	7.1	162	0.76	0.29	0.13	0.11	124	26	0.02	104	26

* nd = non detectable

Well No.	Total Dissolved Solids (mg/l)	Total Organic Carbon (mg/l)	Total Solids (mg/l)	Nitrite (mg/l)	Barium (mg/l)	Copper (mg/l)	Zinc (mg/l)
1	263	3.0	277	0.31	0.02	0.02	0.02
2	295	3.0	313	0.31	0.03	0.01	0.02
4	285	2.0	293	0.31	0.03	0.00	0.02
5	255	2.8	260	0.31	0.03	0.03	0.02

Appendix N

Sequestering Agent

PRODUCT BULLETIN — JP-7

Superior performance by design
JAEGER PRODUCTS, INC.

JAEGER PRODUCTS JP-7

JP-7 is a proven technology, linear chain, polymerized phosphate. The non-toxic formulation specifically sequesters soluble iron, manganese, calcium, magnesium and silica in the water. JP-7 also acts as a corrosion inhibitor, laying down a microscopic film to lower the corrosion rates of iron, copper, lead and other piping materials.

JP-7 is a liquid, inorganic polyphosphate produced using the latest techniques in thermally reacted chemical manufacturing. It is manufactured to meet certification by the National Sanitation Foundation (NSF), United States Department of Agriculture (USDA) and the United States Environmental Protection Agency (USEPA). JP-7 performs as a superior sequesterant, dispersant and buffering agent in water systems where the requirement of potability must be met. To meet a variety of water quality challenges, JP-7:

- Reduces operating costs
- Inhibits scale formation
- Controls fouling caused by iron and manganese
- Removes existing tuberculation
- Assists in controlling algae growth by penetrating biofilm layer

DOSAGE RATES

Dosage rates for individual systems can be determined by Jaeger Products by evaluating current treatment and the type and condition of system. JP-7 is easily dispensed from the shipping container. No mixing is necessary, saving time and labor.

SHIPPING-HANDLING-STORAGE

JP-7 is available in containers ranging from one gallon to bulk tank quantities and can be shipped directly from our manufacturing facility or our Houston warehouse. JP-7 should be stored in clean, dry area for quality assurance. Keep the container closed when not in use and protect from freezing and extreme heat.

PROPERTIES

- Meets NSF Standard 60
- Indefinite shelf life
- Totally soluble
- Freeze/thaw stable
- 11.4 pounds per gallon
- pH (1% solution) — 6.8
- No taste or odor
- Contains no zinc

1611 Peach Leaf • Houston, Texas 77039
Phone: (281) 449-9500 • FAX: (281) 449-9400
(800) 678-0345

Appendix O

Independent Technical Review

INDEPENDENT TECHNICAL REVIEW	DATE October 15, 2007	PAGE 1 of 2
Project: Conceptual Design Report – pH Level Control and Greensand Filter Study		
Discipline: __ Architecture X Civil __ Structural __ Electrical __ Mechanical Reviewer: Scott Byram		
Action Codes: A- Agree Change will be made E- Exception D- Delete-Change not needed		

Comment No.	Reference	Comment	Review Action
1	Table 2-3	Units for conductance are microSiemens (uS)	A-Changed to micromhos per centimeter
2	Table 3-2	Cost info missing	A-Cost information has been added.
3	Table 3-2	I don't see how replacing manhole covers will keep dissolved CO2 levels up. The tank has to be vented to atmosphere, so ambient air must always be present over the water surface. It will keep the water cleaner however.	A-Changed text to say replacement recommended to prevent unwanted discharges into sewer
4	Page 4-7 #4	Do we mean shieve (for blower) rather than sleeve?	D-Monarch indicated sleeve.
5	Page 4-12	Controls – What problem are we trying to solve here? The existing tank level based control setup sounds typical to me. It's all based on demand anyway so adding VFD at the user location won't help much, it just makes more complication.	E-Concerned that controls not being used as initially designed. CRREL has indicated that reservoir levels reach extremes often causing dirupttion of flow to Main Lab. Using VFDs would allow continuous flow through filters and towers.
6	Page 4-12 and 4-13	Backwash – Is this necessary? What problem are we trying to solve here? Are they short of backwash supply? Wouldn't it be better to add clearwell volume (if necessary) rather than add another layer of controls?	E-Not short of supply; Problem is levels in reservoirs reach extremes

INDEPENDENT TECHNICAL REVIEW	DATE October 15, 2007	PAGE 2 of 2
Project: Conceptual Design Report – pH Level Control and Greensand Filter Study		
Discipline: __ Architecture X Civil __ Structural __ Electrical __ Mechanical Reviewer: Scott Byram		
Action Codes: A- Agree Change will be made E- Exception D- Delete-Change not needed		

Comment No.	Reference	Comment	Review Action
7	Page 4-13	IMHO 12 years without cleaning or media replacement is pretty good performance for air stripping towers. Periodic acid cleaning for scale removal is a good idea. Frequency is typically based on observed TCE removal efficiency of the towers.	A-Cost for periodic cleaning may be as much as media replacement. Monitoring required to determine which is economically the best choice. Note: TCE removal rates were adequate at time of media replacement.
8	Page 4-13	The iron is not really a food source for the bacteria, it is an electron donor. The bugs function by oxidizing Fe^{+2} to Fe^{+3} in the presence of oxygen (which will also oxidize Fe^{+2} as well).	A-Will clarify.
9	Table 4-5	Missing cost info.	A-Cost info added.
10	Table 4-5	Not iron "eating", rather iron oxidizing.	A-Will clarify.
11	Page 4-17 # 1	The lab data is showing good iron removal through the filters. The deposition on the air stripper media is $CaCO_3$ scale. The black stuff in the upper portion of the air stripper column may be biological (Fe bugs), or may be $Mn(OH)_2$, or both.	A-Will add possibility of Mn deposits.
12	Page 4-17 #3	Same comment re "iron eating"	A-Will clarify
13	Page 4-18 paragraph 2	Oxidizing the Fe^{+2} with O_2 is OK provided it is followed by filtration. Then the iron bacteria wouldn't be needed for removal as the resulting $Fe(OH)_3$ would be captured by the filters.	E-Only enough oxygen is needed for bio activities; Oxygen not at levels required for oxidation of iron by oxygen alone; Also oxidation of iron by oxygen is relatively slow

INDEPENDENT TECHNICAL REVIEW	DATE October 15, 2007	PAGE 3 of 2
Project: Conceptual Design Report – pH Level Control and Greensand Filter Study		
Discipline: __ Architecture X Civil __ Structural __ Electrical __ Mechanical Reviewer: Scott Byram		
Action Codes: A- Agree Change will be made E- Exception D- Delete-Change not needed		

Comment No.	Reference	Comment	Review Action
14	Page 4-18 Sequestering	Adding chlorine would oxidize the Fe+2, to Fe+3 probably making sequestering unnecessary (provided that filtration follows the Cl addition).	E-Chlorine added after sequesterant; Nalco indicates iron will not be oxidized
15	Page 4-18 Sequestering	Need to verify that we won't get foaming in the air strippers after addition of sequestering agent.	A-Added info on foaming to report
16	Page 4-19	Test the sequestering agent if the client wants to, but I can't say I agree with its use here.	A-Changed recommendation to not use sequestering agent at this time
17	General Comment	If CRREL can get their pH limits modified good. If not an end of pipe recarb step (ie final pH adjustment) would seem to me to be the most cost effective method for pH management.	A-Modified report to indicate end point pH adjustment.