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A field-scale plant for the treatment of explosives-contaminated groundwater was designed and constructed at the Cornhusker Army Ammunition Plant (CAAP) near Grand Island, Nebraska. The target compounds were trinitrotoluene (TNT), trinitrobenzene (TNB), (N)-trinitro-*1,3,5*-triazacyclohexane (RDX) and other nitrobodies. The process chosen was oxidation with a combination of ozone and hydrogen peroxide (Peroxone). The plant was capable of treating 25 gal-min^{-1} with a dose of ozone as high as 55 mg-L^{-1} in each of six bubble column reactors with hydraulic retention times of 24 minutes per reactor. Hydrogen peroxide was fed in the influent water prior to ozonation. The purpose of the study was to determine the feasibility and projected costs for reducing explosive compounds level to 2 µg-L^{-1} for the specific nitro-compounds and 30 µg-L^{-1} for total nitrobodies. The demonstration was carried out over a period of three months. The results showed that the Peroxone process is capable of oxidizing all of the target compounds but very large doses of ozone and hydrogen peroxide are required to reach the target level for TNB, the most recalcitrant target compound. An empirical model was developed as a design tool to provide information on system scale up to 1000 gal-min^{-1}. This model provided not only technical feasibility on scale up, but also a preliminary cost evaluation. A report prepared by the project independent evaluator discusses cost implications in much more detail. Recommendations for further work and for potential cost minimization measures are presented.

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TECHNICAL REPORT

PEROXONE GROUNDWATER TREATMENT DEMONSTRATION PROGRAM CORNHUSKER ARMY AMMUNITION PLANT GRAND ISLAND, NEBRASKA

February, 1998

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ABBREVIATIONS & ACRONYMS

BGS	Below Ground Surface
CAAP	Cornhusker Army Ammunition Plant
COE	U.S. Army Corps of Engineers
CP	Control Panel
CSTR	Continuously Stirred Tank Reactor
DESA	Defense Evaluation Support Activity
EBCT	Empty Bed Contact Time
EPA	U.S. Environmental Protection Agency
FPM	Feet Per Minute
GAC	Granular Activated Carbon
GPM	Gallons Per Minute
HDPE	High density polyethylene
HOA	Hand-Off-Auto
HP	Horse Power
HRT	Hydraulic Retention Time
lb	Pound
LOX	Liquid Oxygen
mA	Milli Amp
mg/l	Milligram per liter
NDEQ	Nebraska Department of Environmental Quality
O&M	Operations and Maintenance
ORP	Oxidation-Reduction Potential
PFD	Process Flow Diagram
PSA	Pressure Swing Absorption
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RO	Reverse Osmosis
SCFH	Standard Cubic Feet Per Hour
SCFM	Standard Cubic Feet Per Minute
SOC	Synthetic Organic Chemical
SOW	Statement of Work
SS	Stainless Steel
TDH	Total Dynamic Head
TNT	2,4,6-trinitrotoluene
TNB	1,3,5-trinitrobenzene
TOC	Total Organic Carbon
USAEC	U.S. Army Environmental Center
VOC	Volatile organic compounds
VSA	Vacuum Swing Absorption
WES	Waterways Experiment Station
µg/l	Microgram per liter

1.0 INTRODUCTION

1.0.0.1. This document presents the objectives, design details, and results of the Peroxone Groundwater Treatment Demonstration Program (Program) that was conducted at the Cornhusker Army Ammunition Plant (CAAP) in Grand Island, Nebraska (Figure 1-1). The Program was carried out under the auspices of the US Army Environmental Center (USAEC) with technical assistance from the US Army Corps of Engineers, Omaha District (COE) and the Defense Evaluation Support Activity (DESA). A Project Advisory Board was formed from representatives of the above organizations, as well as two project technical advisors: Professor William Glaze from the University of North Carolina, and Mr. Kerwin Rakness of Process Applications, Inc. Dr. Glaze is an international expert on advanced oxidation processes, and Mr. Rakness has extensive experience in the design and optimization of ozonation systems. The Project Advisory Board reviewed the project progress and provided guidance to the project team throughout the project duration. All major project decisions were made with consultation and approval from the Advisory Board.

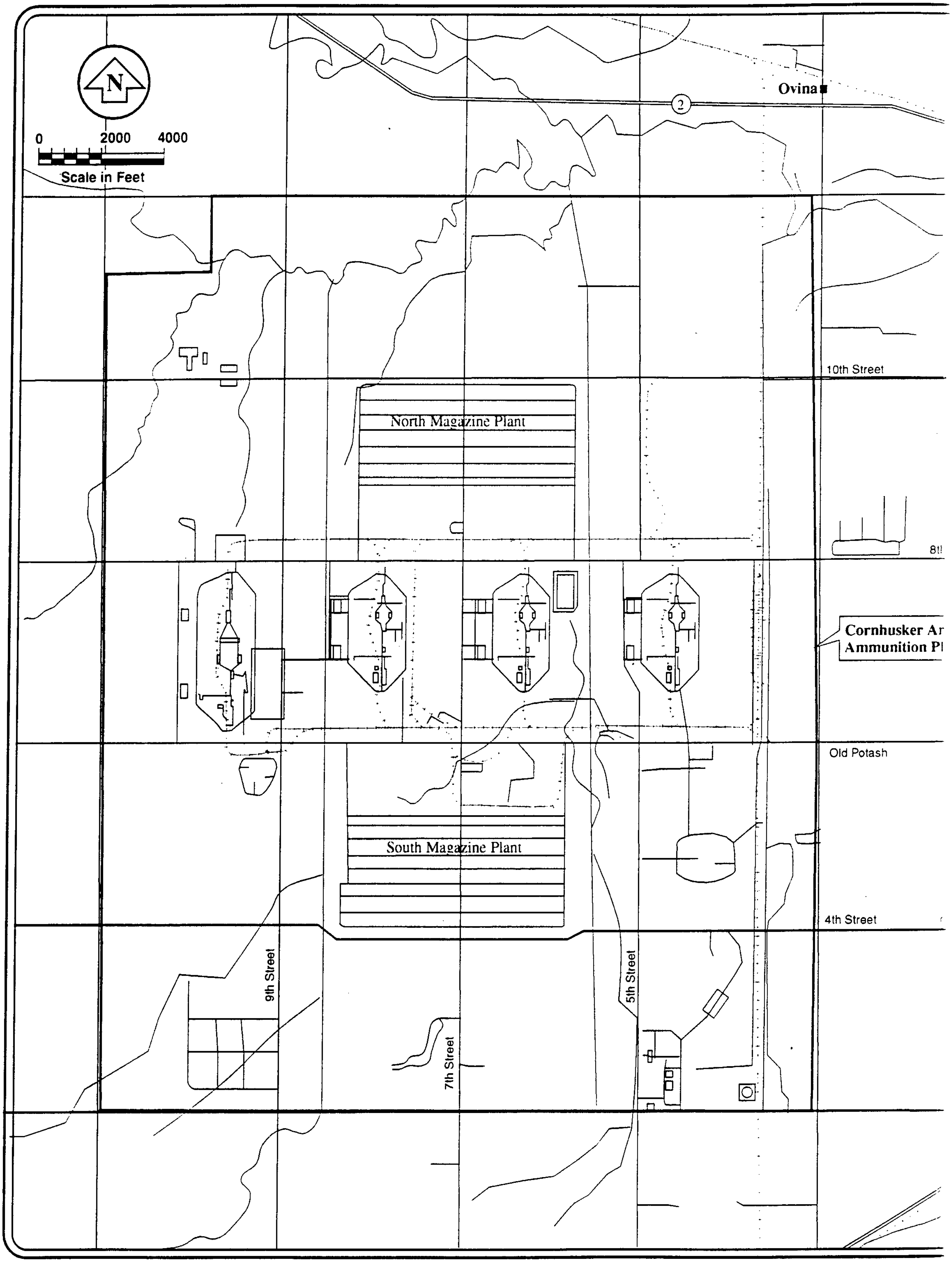
1.0.0.2. The Program, which was implemented by TRW and Montgomery Watson was intended to demonstrate the effectiveness of Peroxide/Ozone (Peroxone) oxidation treatment for groundwater impacted with explosive compounds. Explosives-contaminated groundwater exists at CAAP as a result of load, assembly, and packing (LAP) of explosives into munitions for World War II, the Korean conflict, and the Vietnam conflict. The contaminants of concern include 2,4,6-trinitrotoluene (TNT); 1,3,5-trinitrobenzene (TNB); hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); and other nitrobodies.

1.1 PURPOSE AND OBJECTIVES

1.1.0.1. The purpose of the Program was to demonstrate the technical and economic feasibility of the Peroxone system to remediate explosives-contaminated groundwater at the CAAP.

1.1.0.2. The following objectives were established for the demonstration program:

- Further define the Peroxone system treatment requirements for nitrobodies



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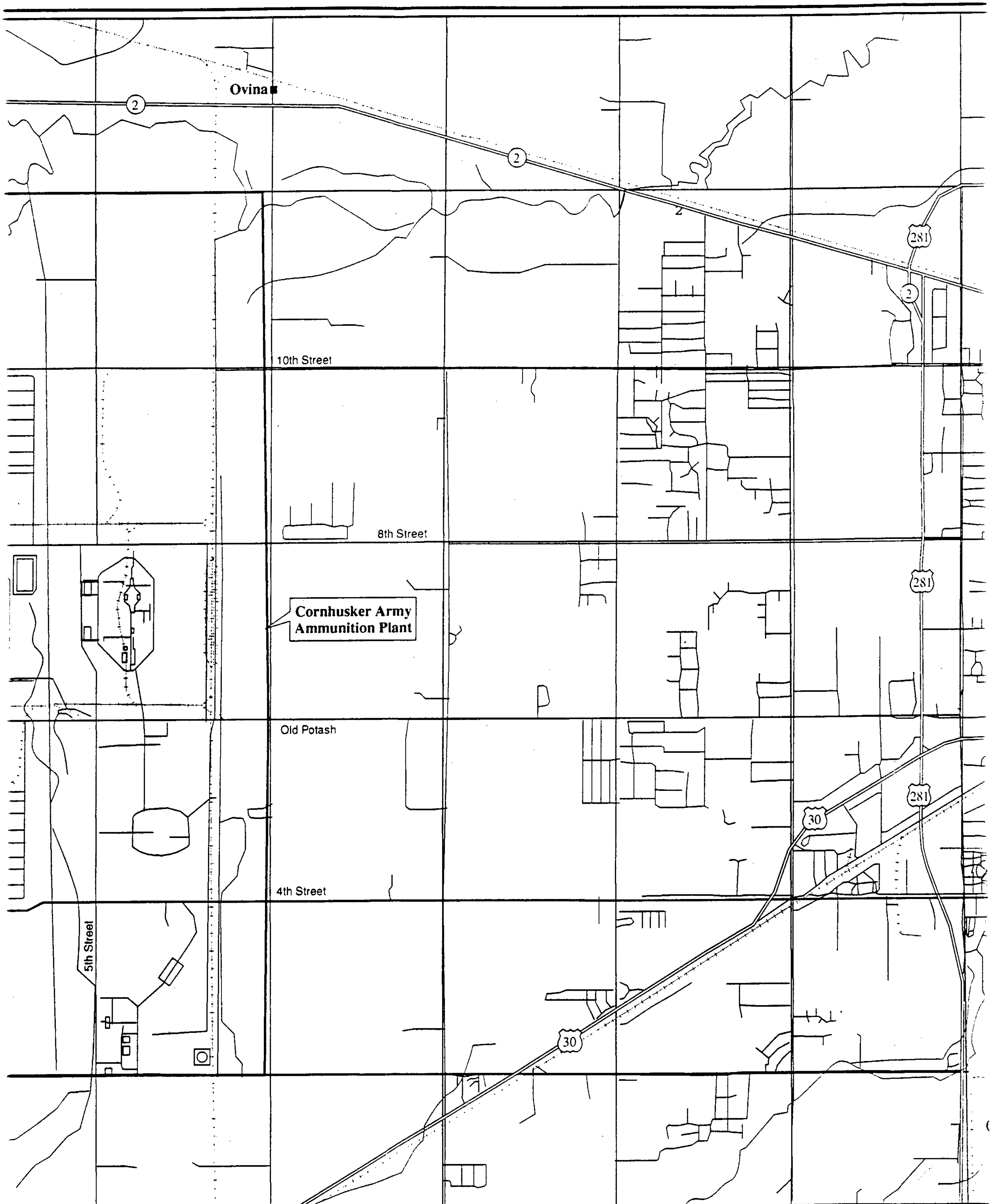

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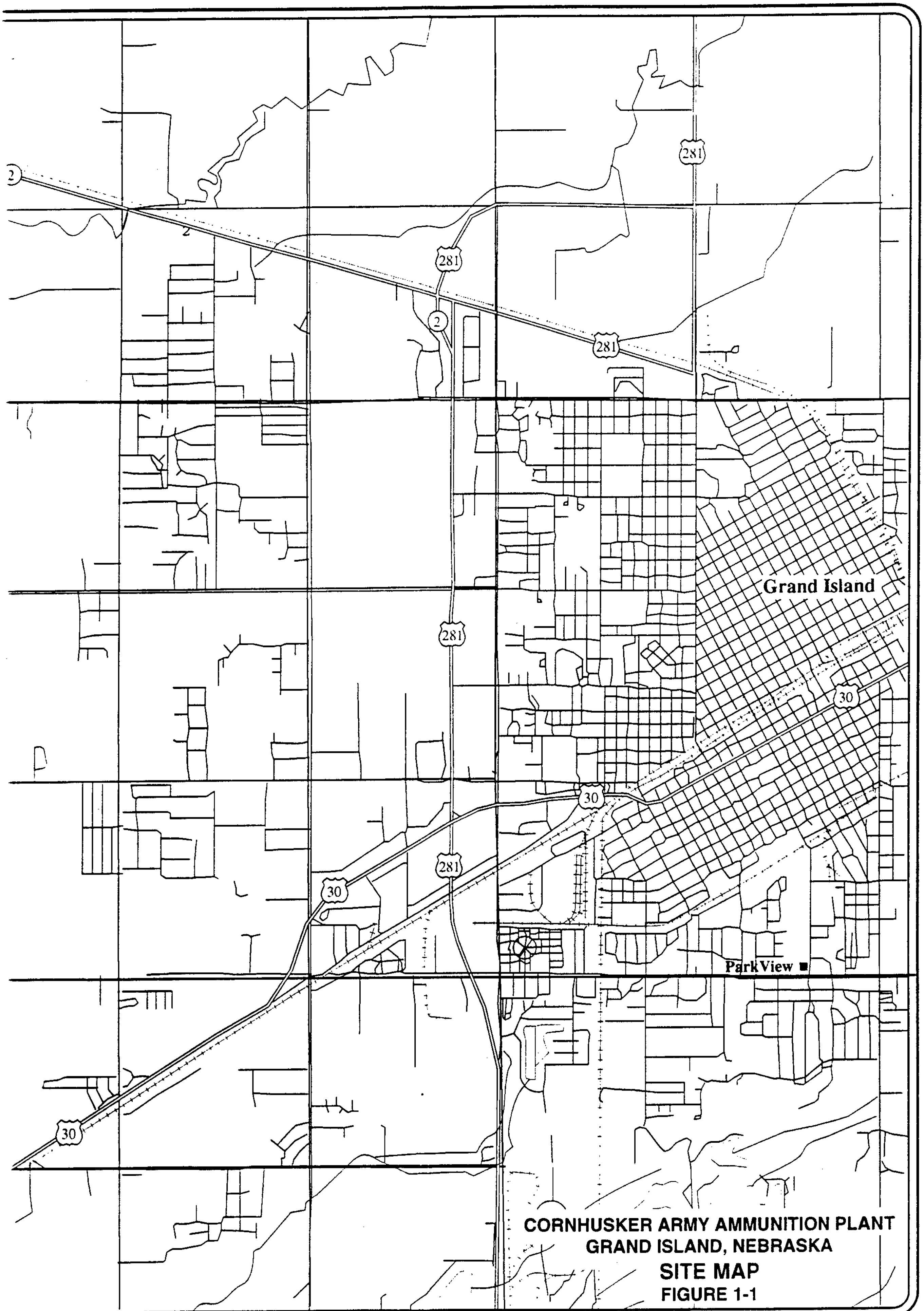

CORNHUSKER ARMY AMMUNITION PLANT
GRAND ISLAND, NEBRASKA
SITE MAP
FIGURE 1-1

- Design and construct a field-scale Peroxone system based on the requirements developed by the Technical Advisory Board and included in the Statement of Work (SOW) and results of the WES pilot-scale testing.

- Conduct demonstration testing of the Peroxone system and gather the necessary data to perform a technical and economic evaluation of the Peroxone system for treatment of explosives-contaminated groundwater.

- Develop recommendations on the feasibility of using Peroxone technology for a full-scale treatment system.

1.1.0.3. This document presents a summary of the activities undertaken to complete the above objectives and the results obtained during the demonstration testing. This document further evaluates the demonstration testing results to provide recommendations for a full-scale Peroxone system.

1.2 PROJECT BACKGROUND

1.2.0.1. Numerous US Army installations have sites that contain groundwater that has been contaminated with explosives. The use of granular activated carbon (GAC) is listed as the best available technology by the United States Environmental Protection Agency (U.S. EPA) for removal of such organic compounds from water. The disadvantage of using GAC is that it accumulates organic compounds on the carbon medium instead of actually destroying the contaminants. There are also problems associated with disposal of explosives-laden GAC. Processes which result in the immediate destruction of the contaminants and are more cost effective than GAC are being sought for the restoration of Army sites.

1.2.0.2. The effectiveness of chemical oxidation is highly dependent on the nature of the organic compounds, the oxidant used, and other contaminants in the water. Among the most promising oxidation processes is the ozone decomposition initiated by hydrogen peroxide.[*] Hydrogen peroxide alone is a moderately powerful oxidizer, but in combination with ozone it is even more powerful because hydroxyl radicals are generated. The hydroxyl radicals that form in a Peroxone system are more effective than ozone alone for oxidation of natural and synthetic organics.[*]

[*] AWWARF & CGE. "Ozone in Water Treatment: Applications and Engineering," Cooperative Research Report, Lewis Publishers, Chelsea, MI, (1991).

1.2.0.3. The Corps of Engineers Waterways Experiment Station (WES) has developed a laboratory scale Peroxone system for the treatment of explosives-contaminated groundwater. Preliminary laboratory results have shown that TNT and RDX are oxidized by this system. In August 1995, a 2-gpm laboratory scale pilot system was field-tested by WES at the CAAP.[i]

1.3 SCOPE OF THE DEMONSTRATION PROGRAM

1.3.0.1. The scope of the demonstration program was limited to the following:

- Design, construct, and operate a 25-gpm Peroxone groundwater treatment system at the CAAP in accordance with the requirements of the Technical Advisory Board.
- Conduct a 12-week demonstration test in accordance with the approved experimental plan.
- Analyze data from demonstration testing to evaluate effectiveness of the Peroxone system in treating explosives-contaminated groundwater.
- Develop recommendations for a 1,000 gpm Peroxone system based on the demonstration testing results.

1.4 ORGANIZATION OF THE REPORT

1.4.0.1. Section 1.0 presents the Program goals and objectives and provides the background for the Peroxone technology and the CAAP Program. The Peroxone system design details are presented in Section 2.0. Section 3.0 describes the activities undertaken during the Peroxone system construction and installation. Details about the demonstration testing and results obtained during the testing period are presented in Section 4.0. The system demobilization and the site restoration activities performed at the conclusion of the demonstration testing are summarized in Section 5.0. Results obtained during the demonstration testing were evaluated to develop recommendations for a full-scale Peroxone system. Section 6.0 presents the evaluation process and provides recommendations for a full-scale Peroxone system for treatment of explosives-contaminated groundwater.

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[i] Fleming, E.C., M.E. Zappi, J. Miller, R. Hernandez, and E. Toro (1997). "Evaluation of Peroxone Oxidation Techniques for Removal of Explosives From Cornhusker Army Ammunition Plant Waters", Technical Report SERDP-97-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

1.4.0.2. The sequence of construction for the Peroxone system is presented using a series of photographs which are included in Appendix A. The results obtained during the optimization period are listed in Appendix B. The results of the demonstration testing are summarized in Appendix C. The as-built drawings for the Peroxone system are included in Appendix D. The project Experimental Plan is included in Appendix E. (The actual experimental approach differed slightly from the experimental plan due to the ongoing analysis of the results during the course of the project. The deviations are explained in Section 4.0 of this report). The project team contact list is included in Appendix F.

2.0 PEROXONE SYSTEM DESIGN

2.1 INTRODUCTION

2.1.0.1. This section presents the details of the Peroxone system used to conduct the CAAP demonstration testing program. It is noted that the process selection and configuration was specified by the Technical Advisory Board with the concurrence of USAEC. The system design criteria is presented in Table 2-1 (A schematic of the treatment system is depicted in Appendix E, Figure 1). It is noted that photographs of the treatment system during construction are shown in Appendix A of this report.

Table 2-1

Demonstration Program Peroxone System Design Criteria

Equipment	Description	Criteria
Extraction Well	Number of existing wells	2
	Existing well casing	4" or larger
	Groundwater level	11 feet bgs (appr.)
	Well head finishing	Above ground with no vaults
Extraction Pump	Number of pumps	2 (one for each well)
	Type	Submersible, electrical
	Capacity	25 gpm each
	Total dynamic head	One at 75 feet TDH; One at 90 feet TDH
	Pump horsepower	3/4 Hp (each)
	Control	Local control panel
	Manufacturer	Grundfos - Clovis, CA
Conveyance Line	Total length	1,130 feet (600 ft and 530 ft from the wells, respectively)
	Size and material	2" PVC, Sch 80
	Type	Single wall, above ground
Influent Flow Meter	Range	0-30 gpm
	Type	Paddle wheel
	Indicators	Instantaneous flow/totalizer
	Signal type	4-20 mA
	Manufacturer	Signet Scientific - El Monte, CA

Table 2-1

Demonstration Program Peroxone System Design Criteria (Continued)

Equipment	Description	Criteria
Ozone Contactor	Number of contactors	6
	Type	Unpacked column with co-current and counter-current flow; saddles for packing ring
	Capacity	500 gal (each)
	Size	3 feet diameter, 10 feet above diffuser; 13 feet total height
	Material	304 SS
	Diffuser type	Ceramic Dome diffuser
	Level indicator	Sight glass
	Fabricator	Denver Mineral Corporation - Denver, CO
Effluent Tank	Capacity	500 gal
	Type	HDPE
	Control	High-level alarm (system shut off) Low-level stop switch
Sump Pump	Number	1
	Type	Submersible, electrical
	Capacity	25 gpm
	Total dynamic head	25 feet (max)
	Control	Internal float switch
	Manufacturer	Little Giant - Ryan Herco (rep)
GAC	Number of vessels	3 in series
	EBCT	30 min. total at 25 gpm flow
	Carbon Quantity	1,000 lb./unit
	Manufacturer	Calgon Corp. - Pittsburgh, PA
Effluent Flow Meter	Range	0-30 gpm
	Type	Paddle wheel
	Indicator	Instantaneous/totalizer
	Signal type	4-20 mA signal
	Manufacturer	Signet Scientific - El Monte, CA

Table 2-1

Demonstration Program Peroxone System Design Criteria (Continued)

Equipment	Description	Criteria
Ozone Generator	Capacity	100 lb./day
	Ozone Dosage (each vessel)	55 mg/l at 10% O_3 at 25 gpm
	Flow measurement	Rotameter (internal)
	Control Panel	Local control panel
	Dosage control	Flow paced
	Manufacturer (rented)	Ozonia - Lodi, NJ
Hydrogen Peroxide System	Capacity	16 lb./day of 35% solution
	Storage	55-gallon drums of 35% solution
	Applied dosage	18 mg/l (total) at 1.5% solution at 25 gpm
	Feed pump type	Pulsafeeder
	Number of pumps	6 (one for each reactor)
	Pump flow rate	0.75 gph (max)
	Control panel	Local control panel
	Dosage control	Flow paced
Sodium Thiosulfate System	Storage	50 lb. bags; photo grade
	Applied dosage	7 mg/L per mg/L residual ozone
	Feed pump type	Pulsafeeder
	Number of pumps	1
	Pump flow rate	3 gph (max)
	Control panel	Local control panel
	Dosage control	Flow paced
Oxygen Storage Tank	Capacity	3,000 gal
	Type	Liquid oxygen mixed with 3% nitrogen
	Owner (rented)	Linweld - Grand Island, NE
Oxygen Vaporizer	Capacity	500 scfh at 15 psi discharge
	Controls	Local/Manual
	Owner (rented)	Linweld - Grend Island, NE

Table 2-1

Demonstration Program Peroxone System Design Criteria (Continued)

Equipment	Description	Criteria
Ozone Destructor	Capacity	8 scfm
	Controls	Local/Manual
	Manufacturer (rented)	Ozonia - Lodi, NJ
Ozone Monitor	High concentration	1
	Ambient concentration	1
Off-gas Stack	Height	20 ft
	Velocity	100 fpm
	Size	2 inch
	Material	Carbon steel
Alarm System	System shut-down mode	High-level alarm in effluent tank Major equipment failure
	Control logic	PLC control with auto dialer for off-hour operation
Process Piping	Type	Single wall
	Size and Material	3" PVC, Sch 80
Containment Pad	Size	30-feet x 40-feet x 12-in (wall)
Utilities (provided by owner)		
Water	Capacity	150 gpm tap water
Electricity	Capacity	480V, 3 Phase, 200 Amp
Sewer	Capacity	150 gpm
Control/Equipment Room (provided by owner)	Number	2
	Size	20-feet x 20-feet (each)
Operation Mode	Normal mode	Automatic with PLC control and monitoring
	Number of operators	2
	Operator hours	40 hr/wk/operator

2.1.0.2. The basic design of the process components was defined by the Technical Advisory Board with concurrence of USAEC based on the results of the previous testing conducted by WES. Minor modifications were made during the construction and demonstration testing phases, however, and these changes are discussed in the following text. The information presented in the SOW was used to develop the design criteria and to prepare the Peroxone system design.

2.1.1. Sources of Contaminated Water

2.1.1.1. Two (2) existing groundwater wells (Well No. 66 and New TRW Well, also referred to as Wells A and B, respectively, in Appendix E) were used to provide contaminated water to the Peroxone system. Each well was assumed to be capable of producing a continuous flow of 25 gallons per minute (gpm). However, this assumption proved to be false for one of the wells as testing progressed.

2.1.2. Design Hydraulic Capacity

2.1.2.1. The Peroxone system was sized for a maximum hydraulic capacity of 25 gpm. This assumed that either one well is operated at a given time, or that the combined flow from the two wells would not exceed 25 gpm.

2.1.2.2. The components designed for a 25 gpm hydraulic capacity include the groundwater extraction well pumps and the conveyance pipe, ozone contactors, activated carbon vessels, and appurtenance. The system support facilities were also sized to handle a maximum flow of 25 gpm at the design influent concentrations discussed below. Flexibility was provided to turn-down the Peroxone system to handle a lower flow; however, no provisions were provided for an effective treatment at a higher flow rate.

2.1.3. Influent Concentrations and Treatment Goals

2.1.3.1. The anticipated influent concentrations in the groundwater are listed in Table 2-2. During the design period, no information was available on expected influent concentrations from individual wells. After that time, data were collected for actual influent concentrations from individual wells and are included in Section 4.0. The treatment goals listed in Table 2-2 represent the effluent limits established by the Nebraska Department of Environmental Quality (NDEQ) for discharge of treated water to a swale or to a storm drain. The GAC effluent stream met these limits without exception during the demonstration period.

Table 2-2

Design Influent Concentrations and Treatment Goals

Contaminant	Design Influent Concentration (µg/L)	Target Treatment Goals (µg/L)
TNT	500	2
RDX	200	2
TNB	100	2
Total Nitrobodies	1,000	30

2.2 EXTRACTION SYSTEM

2.2.1. Extraction Wells

2.2.1.1. The existing groundwater wells were 4-inch in diameter with a capped riser on top. The boring logs indicated that the groundwater table was at approximately 11 feet below ground surface (bgs) for both wells. This proved to be true in the field.

2.2.1.2. Each well was equipped with an electric submersible pump rated for 25 gpm maximum flow. The electric pump assembly was to include a power supply and a local disconnect switch for isolation of individual wells. A junction box was installed instead of the disconnect switch. This still allowed removal of the pump, but ensured that the operator turned off and locked out power at the main control panel.

2.2.1.3. A 2-inch Schedule 80 PVC pipe was used for connecting the wellhead to the conveyance pipe. A ball valve was installed to control the actual flow from each well. Due to the short duration of the demonstration project, an above-ground well vault was not provided; however, temporary barricades were located at the wellhead to protect the wellhead equipment from accidental damage.

2.2.2. Conveyance Piping

2.2.2.1. An above-ground, single-walled, 2-inch Schedule 80 PVC pipe was used to convey extracted groundwater to the Peroxone system. The Schedule 80 pipe offered additional strength to minimize accidental damage. Individual pipe runs from extraction wells were manifolded to provide a single run to the Peroxone system.

2.2.2.2. A flow meter with a range of 0-30 gpm and equipped with a local indicator and totalizer was installed on the conveyance pipe to record flow rates from individual wells and to provide information needed for system operation. The flow meter was located at the treatment pad for ease of readout and maintenance. The flow meter was calibrated using a 50-gallon barrel and a stop watch for three flow rates.

2.3 PEROXONE SYSTEM DESCRIPTION

2.3.1. Ozone Contactors

2.3.1.1. Six (6) conventional, bubble-diffuser type contactors were used to accomplish the chemical oxidation. Each contactor was 3 feet in diameter with a 10-foot side wall depth above the diffuser base. Each contactor provided a retention time of approximately 20 minutes at a flow rate of 25 gpm. A 2-foot head space was provided in each contactor above the water column for off-gas collection.

2.3.1.2. The contactors were 1/8-inch thick, 304 stainless steel (SS 304) shells with 3/16-inch SS 304 top and bottom plates. Each contactor included a 20-inch manway integral to the contactor shell. The manway was located near the bottom of the contactor and was used to position the dome diffuser. It was noted during construction and debugging that the manway was critical to making alignments and repairs. A clear sight glass was included with each contactor for visual observation of the water level inside the contactors. However, visual inspection of the interior of the contactor through the sight glass proved to be difficult due to the inavailability of sufficient lighting to the inside of the contactor.

2.3.1.3. The first contactor was provided with additional features to allow further studies in the future. An additional 20-inch manway opening was located near the top of the contactor. The top manway may be used in the future to fill the contactor with packing material. A saddle ring to facilitate packing of the contactor in the future and two, 2-inch clear acrylic windows were also included in the first contactor to allow observation of the bubble pattern and size.

2.3.1.4. Two dome diffusers were located at the bottom of each contactor to facilitate even distribution of ozone inside the contactors. The number of diffusers per contactor was selected based on the required gas flow rate and the manufacturer's specifications for those specific diffusers. The dome diffusers were 8-inch in diameter and constructed of ceramic material which offers excellent resistant to ozone corrosion. Each contactor was fitted with the diffusers as planned, although several diffusers were replaced during debugging due to irregular bases that did not allow for an air-tight seal around the diffusers.

2.3.1.5. The contactors were designed to operate in both the co-current and the counter-current flow conditions. The piping and valves between the contactors were installed such that the contactors could be manually switched to operate in either co-current or counter-current flow mode. The interconnecting piping between the contactors was Schedule 80 PVC with plastic valves. Although the system was piped for both flow conditions, it was only operated in the counter-current condition during the demonstration testing.

2.3.2. Ozone Generation and Feed System

2.3.2.1. Liquid oxygen was used for ozone generation at the demonstration plant, and was selected for ease of operation and maintenance. Liquid oxygen was stored in a supplier-provided bulk storage tank located adjacent to the treatment pad. A local supplier set up and stocked the tank as planned, then emptied the tank and removed it as planned at the end of the demonstration testing.

2.3.2.2. The ozone generator was designed to deliver an applied ozone dosage of 55 mg/L to each contactor at 10 percent by weight ozone concentration and at a maximum flow rate of 25 gpm. This equates to 100 pounds of total ozone per day for the Peroxone system. A gas flow meter with a local indicator and an ozone monitor was provided to track the ozone generation rate. At each injection point, a local rotameter with a manual control valve was used to calibrate the ozone dosage to an individual contactor. The ozone generator was delivered with all the features expected and produced over 108 pounds per day of ozone, although the full capacity was not used during the demonstration testing. An air compressor was provided to deliver a nitrogen-containing air stream to the oxygen feed flow. The added nitrogen is believed to result in a catalytic reaction that may increase the efficiency of ozone generation by as much as 15% to 20%.

This was based on Montgomery Watson's experience with the design of ozone systems, and the recommendation of the ozone generator supplier.

2.3.2.3. The supply piping from the liquid oxygen tank to the ozone generator was 1 1/2-inch copper pipe specifically designed for liquid oxygen systems. The ozone feed piping was 1 1/2-inch 304 SS. Flexible polyethylene tubing was to be used to connect the ozone feed pipe to individual contactors. The cooling water pipe for the ozone generator was 1 1/2-inch Schedule 40 PVC capable of providing the 70-gpm cooling water flow required for the operation of the ozone generator (required by the generator manufacturer). The copper piping for the oxygen and the stainless steel piping for the ozone feed worked well. During the System Debugging task, the polyethylene tubing degraded under the ozone concentrations used, and was then replaced with high-grade teflon tubing which proved to be resistant to the operational environment at the demonstration testing.

2.3.3. Chemical Feed System

2.3.3.1. The hydrogen peroxide storage system was designed for a thirty-five percent industrial grade solution stocked in 55-gallon drums at the site. The peroxide solution was diluted to 2 percent strength using deionized water from an on-site, ion exchange system. Two, 275-gallon day tanks were used to stock 2 percent peroxide solution which was fed to the Peroxone system. The purpose of diluting the peroxide solution was to increase the volume of the solution actually fed to the contactors, thereby allowing a more precise control over pumping rates and system operation. At times the strength was reduced to 1.5 percent and 1 percent to maintain better control of the peroxide dose.

2.3.3.2. The peroxide solution was fed to the contactors through flexible, polyethylene tubing connected through injection points located in the piping between the contactors. Positive displacement pumps were used to feed peroxide into the system. An individual, dedicated pump was used for each contactor. All pumps fed off a single day tank to ensure that the concentration of the peroxide solution fed to each contactor was constant. Back-pressure control valves were added to the positive displacement pumps to prevent loss of prime on the suction side of the pumps.

2.3.3.3. Sodium thiosulfate was selected to neutralize the residual ozone in the effluent from the contactors. Fifty-pound bags of photograde thiosulfate crystals were stored at the site for this purpose. Thiosulfate solution was prepared on a daily basis using deionized water from an on-site, ion exchange system. Thiosulfate was then fed directly into the effluent tank through a 1/2-inch Schedule 40 PVC pipe. A positive displacement pump was used to feed the thiosulfate solution to the effluent tank. The 1/2-inch PVC feed line into the effluent tank was replaced with a 3/8-inch polyethylene tubing to increase the flow velocity and thus allow for a more efficient pumping system.

2.3.4. Effluent Tank and Effluent Pump

2.3.4.1. Effluent from the ozone contactors was fed into the effluent tank via gravity flow. The effluent tank was used as a reaction tank to neutralize the residual ozone before discharging the water into the GAC vessels as described in Section 2.3.5. This tank was placed next to a sump built into the containment pad. The tank worked well for equalization of the effluent and addition of the thiosulfate solution. It was also connected to the sump pump to permit transfer of rain water or spills on the pad into the tank allowing treatment through the GAC vessels before discharge.

2.3.4.2. An end suction, centrifugal pump rated for 25 gpm at 15 psi total head was used to transfer treated water from the effluent tank through GAC vessels to the discharge connection. The pump worked as expected, outpacing the gravity flow to the effluent tank and allowing intermittent operation of the pump.

2.3.5. Activated Carbon Polishing System

2.3.5.1. Treated water from the Peroxone system was routed through GAC vessels for additional treatment. The GAC system was a vendor-supplied package consisting of three (3) vessels operated in series. Each vessel contained 1,000 pounds of virgin activated carbon and provided 10-minute retention time at a flow of 25 gpm. The total retention time for the GAC system was 30 minutes. The carbon vessels worked successfully, preventing discharge of any contaminants above the permit requirements.

2.3.6. Ozone Destruction System

2.3.6.1. Off-gas from the ozone contactors was collected and treated through an ozone destruction unit. The ozone destruction unit consisted of a dual catalyst bed with an electric heating coil which converts ozone to innocuous byproducts. Exhaust from the ozone destruction unit was discharged to the atmosphere through a stack. The ozone destruction unit was delivered with the ozone generator and worked as planned, reducing ozone gas concentrations in the stack to non-detect levels.

2.3.6.2. Polyethylene tubing was installed on top of each of the ozone contactors for off-gas collection. The tubing was then manifolded into 2-inch Schedule 80 PVC pipe which ran to the ozone destruction unit. During the testing, the polyethylene tubing proved to be incompatible with high ozone concentrations, therefore, the off-gas tubing was changed to teflon to prevent further failures. This piping setup worked well, with no failures detected during the demonstration testing.

2.3.6.3. The exhaust stack from the destruction unit was to be a field-installed PVC vent, but it was changed to 2-inch steel pipe to allow for a more rigid installation without guy wires. Sampling points were located downstream of the destruction unit to collect air samples into a single ozone analyzer. A high ozone condition in the exhaust stack triggered an alarm. The discharge stack was also equipped with a local flow meter to monitor the exhaust flow but the flow rate out of the stack proved to be so low that a manometer and pitot tube had to be used instead to check the flow.

2.4 PROCESS CONTROL NARRATIVE

2.4.1. Groundwater Extraction System

2.4.1.1. As shown in the as-built drawings in Appendix D, each extraction well pump was controlled from a hand switch on the control panel (HS-101 or HS-102). The well pumps shut down automatically from the low flow switch (FSL-200) on the influent pipe, with a time delay to restart the pumps. The well pumps also shut down at a high-level alarm from the first ozone contactor (LSH-301), and the well pump power was interlocked with the main treatment system alarm (Alarm Level I) for an emergency shut off.

2.4.1.2. A flow meter (M-1) was provided with a local indicator/totalizer (FIT-203/FIQ-203) and a pen recorder (FIR-203) to monitor the influent flow rates.

2.4.1.3. The first ozone contactor (OT-1) was equipped with a high water level switch (LSH-301). LSH-301 signaled the system alarm (Alarm Level I).

2.4.2. Peroxide Feed System

2.4.2.1. Hydrogen peroxide was fed from one of the two day tanks (DT-1/DT-2). Each day tank had a low level switch (LSL-601/LSL-602). A selector switch (LSS-600) was included to determine which day tank was to be in service and thus which level switch was functional. LSL-601/LSL-602 were used to shut off the peroxide metering pumps and signal the system alarm (Alarm Level I). The day tanks were connected to the feed lines using ball valves. When the operator wanted to draw from a specific tank, the appropriate valve was opened and the other tank valve closed. The tank low-level switches LSL-601 and LSL-602 were installed as described, but instrumented together. Both switches were operational at the same time, allowing the operator to withdraw solution from both tanks simultaneously.

2.4.2.2. Chemical mixers (MX-1/MX-2) in the peroxide day tanks were controlled manually at the local switch (see Facility Plan in as-built drawings).

2.4.2.3. All peroxide metering pumps were turned on by a single local switch (HS-603) that was interlocked with the low flow switch (FSL-200). In the "ON" position, the pumps automatically turned on or off. The dosage from each metering pump was adjusted manually from the speed and stroke controls on the pump. A dedicated peroxide metering pump was used for each ozone contactor. All peroxide metering pumps were shut off by the level switch (LSL-601/LSL-602) in the peroxide day tank, and interlocked with the system alarm (Alarm Level I).

2.4.3. Ozone Feed and Destruction Systems

2.4.3.1. Ozone was fed from the ozone generator OG-1. A flow meter (FI-300) with a local indicator and a central ozone monitor (AI-300) was included to track the ozone generation rate. At each injection point, a local rotameter (FI-301 through FI-306) with a manual control valve was used to calibrate the ozone dosage to an individual contactor. On the off-gas line from each ozone contactor, the residual ozone concentrations were monitored with a central ozone monitor (AI-300) to track the actual ozone transfer efficiency. The ozone monitoring worked as planned, allowing the operator to observe the ozone absorption concentrations and to adjust each rotameter during the demonstration testing.

2.4.3.2. The ozonator was equipped with vendor-supplied control panel (LCP) for ozone generation rate control, liquid oxygen (LOX) usage, and cooling water systems. The LCP was turned on manually and it was interlocked with the low flow switch (FSL-200). The LCP included an ozonator alarm to shut off the ozonator and to initiate the system alarm (Alarm Level I). The ozonator was also interlocked with the system alarm (Alarm Level I). The LCP alarm was triggered by ozonator malfunction, ozone leak, or an LOX feed problem. The vendor-supplied LCP provided all the controls for the ozone generator, but required a remote connection from the main control panel to ensure a shut down of ozone production if there was a main system alarm or a failure of the ozone destruction unit. This connection worked well and was tripped during actual operation.

2.4.3.3. Off-gas from each ozone contactor was forced through the ozone destruction unit (OD-1) prior to discharge. The destruction unit was equipped with vendor-supplied LCP for controls. The LCP was turned on manually and it was interlocked with a low-flow switch (FSL-200) (see as-built drawing I-1). The LCP was equipped with an alarm to shut off the ozone destruction unit and to initiate the system alarm (Alarm Level I). The ozone destruction unit was also interlocked with the system alarm (Alarm Level I). Discharge from the destruction unit was monitored by the central ozone monitor (AI-300), and was tied to a high ozone concentration alarm (Alarm Level II) at the control panel. The off-gas discharge stack included a flow meter (FI-702) with a local indicator to monitor the discharge flow rate through the stack (OGS-1). These features were installed as specified, although the vendor-supplied LCP did not shut off the ozone destruct unit if a low-flow occurred. Since the unit worked independently of all other components, this was not changed.

2.4.4. Effluent Tank

2.4.4.1. Effluent from the last ozone contactor was designed to gravity flow to the effluent tank (TK-2) which was equipped with three level switches. Switch LSHH-501 (which stands for Level Switch High-High-501) signaled a high-high level alarm (Alarm Level II); switch LSH-501 would turn on the effluent transfer pump (P-2), and switch LSL-501 shut off the effluent transfer pump (P-2) and the thiosulfate metering pump (DF-7). LSLL-501 (which stands for Level Switch low-low-501)signaled an alarm (Alarm Level II).

2.4.5. Thiosulfate Feed System

2.4.5.1. Sodium thiosulfate was fed from a day tank (DT-3). The day tank was equipped with a low-level switch (LSL-611). LSL-611 shut off the thiosulfate metering pump and signaled an alarm (Alarm Level II).

2.4.5.2. Chemical mixer (MX-3) in the thiosulfate day tank was turned on manually at the local switch.

2.4.5.3. The thiosulfate metering pump was turned on by a local switch (HS-610) and it was interlocked with the effluent transfer pump (P-2) fail status. The metering pump was adjusted manually from the speed and stroke controls on the pump. The thiosulfate metering pump was turned off from the low-level switch (LSL-611) in the thiosulfate day tank and it was interlocked with the system alarm (Alarm Level I).

2.4.6. Effluent Transfer Systems

2.4.6.1. Effluent transfer pump (P-2) had a hand-off-auto (H-O-A) switch (HS-502) located on the control panel. When the pump was in AUTO, the effluent transfer pump (P-2) was controlled by the level switches (LSH-501 and LSL-501) in the effluent storage tank (TK-2). The pump was interlocked with the system alarm (Alarm Level I). Instead of locating the H-O-A switch on the control panel, it was located by the pump in the field. Otherwise the pump functioned as designed.

2.4.6.2. Each GAC vessel was to be equipped with a pressure gauge fitting to allow visual observation, but the vendor did not supply the gauges. Since this was not an essential parameter to measure, the pressure gauges were left out.

2.4.6.3. Discharge from the Peroxone system was to be monitored through a flow meter (M-2). The flow meter was equipped with a local indicator/totalizer (FIT-701/FIQ-701) and a pen recorder (FIR-701) located at the control panel. This flowmeter was installed down stream of the carbon contactors.

2.4.7. Support Systems

2.4.7.1. The system alarm (Alarm Level I) was designed to shut off the entire system; the alarm status was displayed on the Control Panel (CP-1). An auto-dialer was to be used to notify the operator of any alarm condition during off-hour operation. The system alarm was connected as designed and successfully shut down the entire system as required. The auto dialer was not installed since the treatment process was monitored full time during the day and would shut down automatically if a failure occurred at night. However, it is noted that no failures or shut-downs occurred during the testing period.

2.4.7.2. Alarm Level II was displayed on the Control Panel (CP-1); however, Alarm Level II would automatically re-set when the alarm condition disappears. This worked as planned with the annunciation light coming on during each Level II alarm.

2.5 TREATMENT PAD

2.5.0.1. The treatment pad was sized to accommodate all components of the Peroxone system except for the liquid oxygen tank and chemical storage. The treatment pad was designed for a seismic zone 1 and for other local conditions per the Uniform Building Code (UBC).

2.5.0.2. A 12-inch berm was provided on all sides of the pad for secondary containment. The containment pad and the berm were designed to provide adequate capacity to hold the volume of all contactors and GAC vessels plus 10 percent. The berm and the pad were constructed as designed and were poured monolithic allowing for a more water-tight structure.

3.0 PEROXONE SYSTEM CONSTRUCTION

3.0.0.1. This section contains a review of the construction portion of the Peroxone system demonstration program. It is organized chronologically by weekly progress. This discussion contains information about successful components of the construction process as well as lessons learned during assembly of the system.

3.1 ADVANCE PREPARATION

3.1.1. Procurement

3.1.1.1. During development of the conceptual design for the system, it was proposed that the individual components be shipped to Montgomery Watson's test facility in California and pre-assembled to ensure proper operation at the CAAP. Montgomery Watson suggested that the schedule could be expedited if the system was assembled and tested on site using a field engineer. After agreement that the schedule was tight and the system should be assembled on site, it became necessary to procure equipment and services immediately as the design was being developed. In order to allow ten weeks of operation before winter set in, it was necessary to construct the system within a window of four to five weeks.

3.1.1.2. Early procurement involved ordering and fabricating the contactor vessels two months ahead of the scheduled construction period. Since the design was in process, the design group was diverted to focus on the long lead items first. The fabrication company was enlisted to help with detailed design issues and the contactors were designed in parallel with the rest of the treatment system. The same approach was used to select the ozone generator.

3.1.1.3. The design documents were abbreviated in detail to expedite the schedule. Any details that were not shown on the design drawings were completed by the on-site Montgomery Watson engineer during field fabrication. This expedited approach saved three weeks in additional engineering time and reduced the subsequent cost of engineering.

3.1.1.4. As soon as the size, model, and the manufacturer of each component were decided, the design was sent out for procurement and scheduled for delivery to the project site during the construction window. Advance procurement of all components proved to be successful, with all equipment arriving before or within the first week of construction. A collection of photographs showing assembly of the system components is included in Appendix A.

3.1.2. Slab Preparation

3.1.2.1. The concrete containment slab for the treatment system required 28 days to cure. Advance procurement of a local subcontractor was necessary to ensure that the slab was ready for system installation as soon as the equipment and materials arrived on the site. A local engineering company was hired to inspect the steel reinforcing prior to pouring concrete, and to take quality control samples during placement of the concrete. The concrete slab was poured the week of 12 July 1996.

3.2 CONSTRUCTION CHRONOLOGY

3.2.1. Extraction Wells

3.2.1.1. Although the original project scope called for the use of three wells for the demonstration testing, the plan was changed to utilize only two wells just before start of construction. The wells had already been installed and developed during the previous studies, so they only required installation of pumps and piping. Both wells were expected to produce 25 gpm in order to operate the treatment system at the design flow rate. After the wells were connected and pumping started, it was discovered that Well 66 would not produce more than 13 to 15 gpm of flow. This reduced flowrate was factored into the demonstration testing. Piping to the wells was completed 19 July 1996, and the pumps were installed and connected 9 August 1996.

3.2.2. Ozone Generator

3.2.2.1. The ozone generator was delivered to the site and set up on 23 July 1996. The liquid oxygen tank for the generator was delivered and set up 25 July 1996 by Linweld, a local oxygen supplier.

3.2.3. Contactors

3.2.3.1. The first three contactors were delivered on 26 July 1996 and the first contactor was set the same day. Piping to the first three contactors was completed 29 July 1996.

The last three contactors were delivered 30 July 1996 and were set and plumbed by 2 August 1996.

3.2.4. Activated Carbon Vessels

3.2.4.1. Three carbon vessels were delivered to the project site on 1 August 1996. They were placed on the pad and connected 7 August 1996.

3.2.5. Reverse Osmosis Unit

3.2.5.1. A reverse osmosis (RO) treatment unit was leased to produce deionized make-up water for the hydrogen peroxide solution. The reverse osmosis unit was delivered and set up 8 August 1996. The unit was leased from Culligan's local distributor.

3.2.6. Sodium Thiosulfate Feed System

3.2.6.1. This system consisted of a chemical metering pump, a mixing tank and a mixer, level controls and the associated piping. The assembly was installed during 5 to 8 August 1996.

3.2.7. Chemical Feed Pumps

3.2.7.1. Six chemical feed pumps were set up and connected to supply and delivery tubing on 5 and 6 August 1996.

3.2.8. Piping and Fittings

3.2.8.1. All piping and fittings for the Peroxone system were connected by the end of the week of 8 August 1996. This included the stainless steel ozone delivery lines, the well water delivery lines, the effluent piping, and the RO effluent water piping.

3.2.9. Water System

3.2.9.1. The potable water system was connected on 7 August 1996. The piping was tested that day for leaks and repaired as required.

3.2.10. Power

3.2.10.1. The power company set the main power supply pole and the three-phase transformers during 29 July 1996 to 2 August 1996. Power conduit and wiring from the control panel was run to the equipment on the pad the week of 5 August 1996. Power connection to the system was completed 6 August 1996.

3.2.11. Instrumentation and Controls

3.2.11.1. Instrumentation wiring was pulled in with the power wiring the week of 5 August 1996. The instrumentation was connected and tested the week of 12 August through 17 August 1996.

3.3 STARTUP

3.3.0.1 Startup of the Peroxone system was divided into three efforts; clean water testing, debugging, and optimization. Clean water testing is discussed below. Debugging and optimization are discussed in Section 4.0.

3.3.1. Clean Water Testing

3.3.1.1. As individual portions of the system were completed they were tested prior to startup. First the conveyance piping was connected to the contactors. The piping and the contactors were then filled with clean water and hydraulically tested for leaks. Then all tanks, piping and tubing on the pad were filled and checked prior to debugging. The carbon vessels were filled with water and the air pressure in each vessel was bled off until they flowed smoothly. The connections were then completed between each GAC vessel to check for leaks under operating pressure. This took place 12 through 14 August 1996.

3.3.1.2. Once the tanks, piping, tubing, and pumps were checked and all repairs completed, the system was turned over to the operator for debugging and optimization testing.

4.0 PEROXONE SYSTEM TESTING PROGRAM

4.1 INTRODUCTION

4.1.0.1. This section describes the testing program implemented at the Peroxone groundwater treatment system. The testing approach and analytical methods used in the program are first described, followed by the experimental conditions and results obtained from each of the optimization and demonstration testing programs. Finally, a mathematical model describing the destruction of TNT, TNB, and RDX with ozone/hydrogen peroxide is proposed. The model is then calibrated using the optimization and the demonstration testing results.

4.1.0.2. The following legend has been used for figures in this section:

INF	-	Influent Concentration
C1	-	Effluent Concentration from Contactor 1
C2	-	Effluent Concentration from Contactor 2
C3	-	Effluent Concentration from Contactor 3
C4	-	Effluent Concentration from Contactor 4
C5	-	Effluent Concentration from Contactor 5
C6	-	Effluent Concentration from Contactor 6

4.2 TESTING APPROACH

4.2.0.1. The overall testing program extended over a period of 12 weeks. After the plant was constructed and all the equipment was installed, the demonstration plant operators conducted three primary tasks: (1) System Debugging, (2) System Optimization, and (3) System Demonstration. The following is a brief description of each task, and they are discussed in more detail later in this section.

4.2.1 Task 1 — System Debugging

4.2.1.1 During this task, which extended over two weeks, the plant pumps and chemical feed systems were started up at a low flow rate (approximately 10 gpm) using tap water, and checked for any water or chemical leaks. The system was also checked for malfunctions of chemical feed equipment and shut-down alarms. After the leaks and malfunctions were adjusted, the flowrate through the plant was continuously increased until the design flow of 25 gpm was reached. The plant was then operated at the design flowrate for a period of two days. During this period all water and chemical feed equipment were checked for operational stability. Tracer testing was also conducted during this phase to characterize the hydraulic residence time distribution of the system. A summary of significant problems and their resolution is discussed in Section 4.5.5.

4.2.2 Task 2 — System Optimization

4.2.2.1 During this task, which also lasted for two weeks, process optimization testing was conducted using water from each of the two test wells. Process optimization involved operating the system at various ozone doses and hydraulic retention times, collecting water samples from the effluent of each of the six contactors, as well as from the wall taps along the water depth of the first contactor, and analyzing them for ozone residual and explosives. The applied ozone dose tested ranged from 38 mg/L to 115 mg/L. The flowrate tested ranged from 13 gpm to 25 gpm. Steady-state conditions were reached (a minimum of 3 hydraulic retention times) before any operational parameter was changed. These optimization tests were used to determine the operating conditions that would result in the reduction of the target contaminants to the desired effluent quality.

4.2.3 Task 3 — System Demonstration

4.2.3.1 During this task, which was conducted over a period of eight weeks, the system was operated under two sets of conditions using water from New TRW Well only.

System demonstration involved operating the system at constant conditions over an extended period of time, collecting water samples from the effluent of each of the six contactors, and analyzing them for ozone residual, pH, oxidation-reduction potential (ORP), and explosives concentrations. These tests served to demonstrate that the system can achieve the anticipated performance on a long-term basis.

4.3 ANALYTICAL METHODS

4.3.0.1. Samples were taken from the Peroxone system influent, the effluent from each ozone contactor, and the effluent of the granular activated carbon (GAC) contactors on a daily basis. The following analyses were routinely conducted on these samples during the demonstration project:

- explosives
- nitrate
- ozone residual
- hydrogen peroxide residual
- oxidation reduction potential (ORP)
- pH
- temperature.

4.3.0.2. Samples were packaged in insulated containers, cooled with ice, and shipped to GP Environmental Labs in Gaithersburg, MD for analysis. A total of 15 explosives contaminants were reported including the three target compounds: TNT, TNB, and RDX. The mass sum of all the compounds analyzed for with EPA Method 8330 and reported by GP Environmental Labs was referred to as Total Nitrobodies. Nitrate samples were routinely taken from the influent and each contactor effluent. These samples were analyzed by GP Environmental Labs using EPA Method 9056. Ozone residual analyses were conducted on site using Standard Method 4500-O_3B Indigo colorimetric method. A known volume of Indigo Reagent II was drawn into a 10-mL gas-tight glass syringe. The remaining volume in the syringe was filled with the sample being analyzed. The absorbance of the mixture at 610 nm was then determined with a Hach DR-700 colorimeter. The hydrogen peroxide residual was measured using the method described by Masschelein et al. (1977).[1] Oxidation-reduction potentials were performed using proposed Standard Method 2580 (ORP). An Orion Model 9678BN oxidation-reduction probe and Orion model 920 ion selective electrode meter were used. pH analyses were conducted on site using a Hach EC-10 portable pH meter and probe with automatic temperature compensation. The temperature of samples was measured using an alcohol thermometer graduated in 1 degree centigrade increments and was recorded during the determination of the oxidation-reduction potential. Tracer tests using Fluosilicic Acid were conducted at process flow rates of 13 and 25 gpm. Fluoride analyses were conducted during tracer testing using Standard Method 4500F. An Orion fluoride probe, Model 9609BN, and Orion model 920 ion selective electrode meter were used.

4.3.0.3. In addition, numerous analyses were conducted by GP Environmental Labs on a less frequent basis. The analyses conducted and methods used are listed below:

• Volatile Organic Compounds	EPA Method 8260
• Semi-Volatile Organic Compounds	EPA Method 8270
• Iron, Calcium, Magnesium, Manganese	SW846, EPA Method 6010
• Nitrate, Nitrite and Sulfate	EPA Method 9056
• Carbonate, Bicarbonate, Ammonia, & Phosphorous, Total Kjeldahl Nitrogen	Standard Method 4500
• Total Suspended Solids, Total Dissolved Solids	Standard Method 2540
• Alkalinity	Standard Method 2320
• Total Organic Carbon	Standard Method 5310

4.3.0.4. It should be noted that all analytical results were proven to be reliable. The QA/QC data for the project are listed in the Independent Evaluator's report.

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[1] Masschelein, W.; M. Denis, and R. Ledent, "Spectrophotometric Determination of Residual Hydrogen Peroxide", *Journal of Water & Sewage Works*, pp. 69-72 (August, 1977).

4.4 GROUNDWATER QUALITY

4.4.0.1. During the beginning of the optimization testing, groundwater samples were collected and analyzed for various general physical/mineral water quality parameters, as well as an array of volatile organic chemicals (VOC). The results of the general/mineral analyses are listed in Table 4-1. Both waters can be characterized as relatively high alkalinity, high hardness waters. The results suggest that Well #66 water had a substantially lower organic content than New TRW Well water.

Table 4-1

General Physical/Mineral Groundwater Quality Characteristics

		Value	
Parameter	**Unit**	**New TRW Well**	**Well #66**
Alkalinity	mg/L as $CaCO_3$	311	326
Nitrate	mg/L	1.41	9.51
Ammonia	mg/L	0.29	13.6
Calcium	mg/L	63.6	82.5
Iron	μg/L	< 52	< 52
Magnesium	mg/L	10.7	16.8
Manganese	mg/L	0.637	0.564
Total Phosphorous	mg/L as P	0.301	0.668
Total Dissolved Solids	mg/L	452	BKN
Total Organic Carbon	mg/L	5.32	1.92
pH	—	7.0	7.0

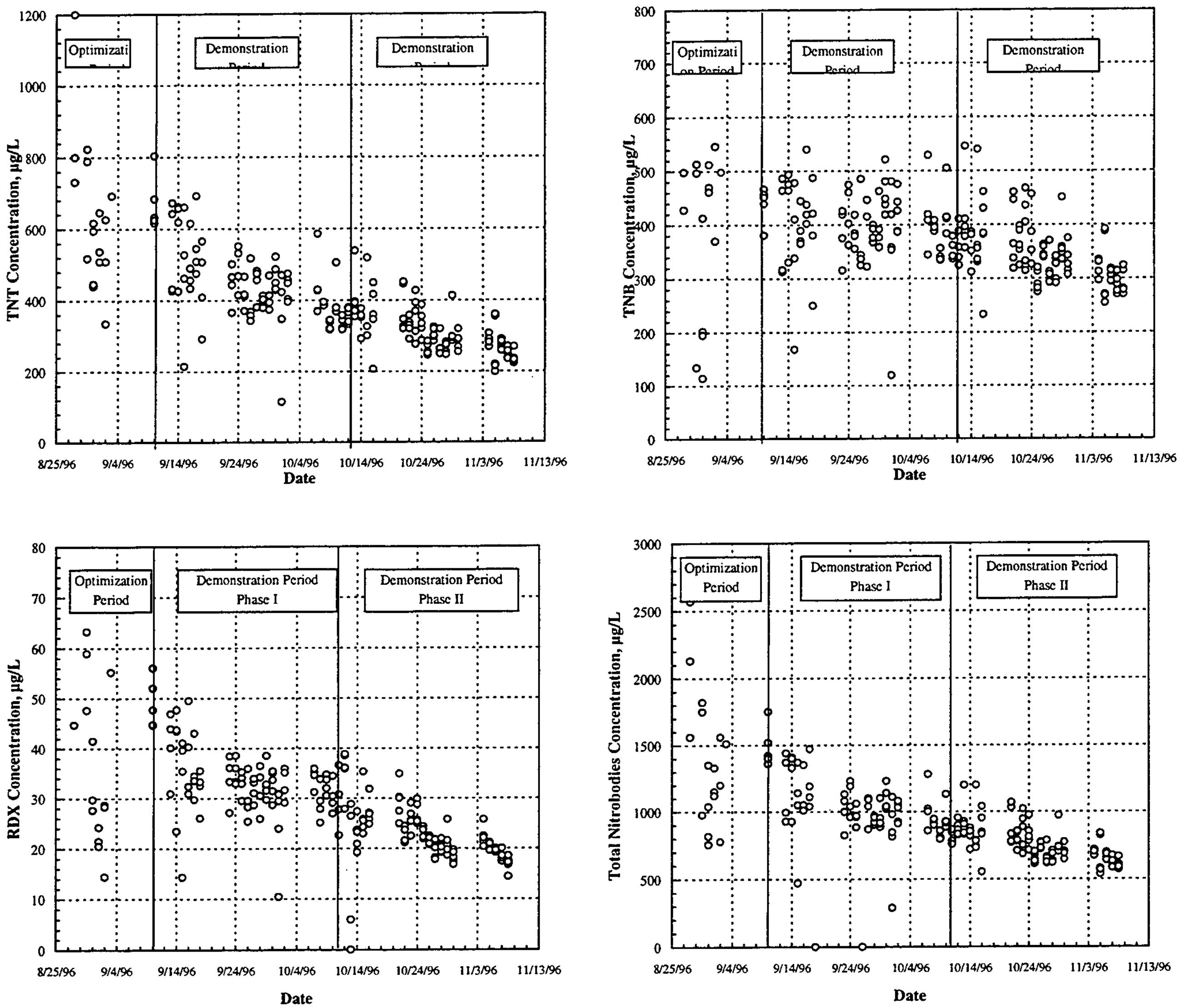
BKN: Broken Sample Vial

4.4.0.2. The types and concentrations of the synthetic organic chemicals (SOCs) analyzed for during the optimization testing period are listed in Table 4-2. The results show that waters from New TRW Well and Well #66 did not contain VOCs above the compound-specific detection limits.

4.4.0.3. In addition, during the optimization testing period and the demonstration testing period, the influent water to the Peroxone treatment system was analyzed daily for explosives, including the target contaminants of TNT, TNB, and RDX. The average concentration and range of each of these compounds, as well as the sum of Total Nitrobodies measured in New TRW Well and Well #66 waters are listed in Table 4-3 for each of the optimization and demonstration testing periods. The results are also plotted in

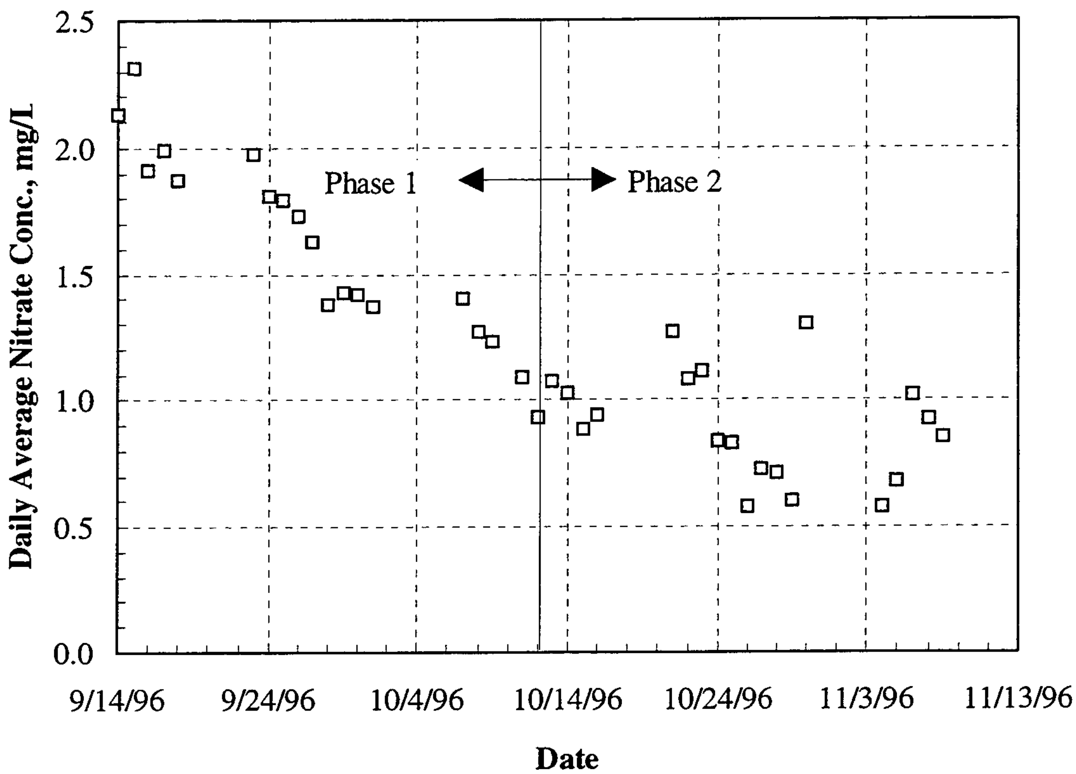
Figure 4-1 on the following page. The analytical results showed that the contaminant concentrations varied significantly throughout the testing period. This wide variation impacted the ability to interpret the Peroxone system performance data since reaching steady-state conditions was virtually impossible. In addition, the data presented in Table 4-3 and Figure 4-1 show that the influent concentrations of all contaminants decreased substantially from the beginning of the project (during the optimization period) to the end of the project (Phase II demonstration period). This should also be considered when comparing the performance of the Peroxone system under the different conditions of the optimization period and the demonstration period. For optimum data analysis, no average influent concentrations were used, but rather each effluent concentration was coupled with its corresponding influent value. In order to facilitate the comparison of system performance under different influent contaminants' concentrations, the performance was expressed in terms of percent removal and not as effluent concentration values.

4.4.0.4. In addition, the analytical results show that the concentration of nitrate in the groundwater decreased through the testing period. Figure 4-2 shows a plot of the daily average concentration of nitrate in the New TRW Well water during Phases 1 and 2 of the demonstration period. The results show that the daily average nitrate level continuously decreased from a high of 2.3 mg/L at the beginning of Phase 1 of the demonstration period to a low of 0.6 mg/L at the end of Phase 2 of the demonstration period. It should be noted that this decrease in influent nitrate level should not have had any impact on the process performance since no reaction between ozone and nitrate is expected because nitrate is the highest oxidation state for nitrogen.



Raw Water Levels of TNT, TNB, RDX, and Total Nitrobodies

Figure 4-1



Nitrate Concentrations in the New TRW Well Water During the Demonstration Period

Figure 4-2

Table 4-2

Types and Concentrations of SOCs in New TRW Well and Well #66 Waters (All Concentrations Were Below the Indicated Detection Limits)

Chemical	Detection Limit (μg/L)	Chemical	Detection Limit (μg/L)	Chemical	Detection Limit (μg/L)
1,2,4-Trichlorobenzene	10.5	Benzo[b]fluoranthene	10.5	1,1,2,2-Tetrachloroethane	5
1,2-Dichlorobenzene	10.5	Benzo[g,h,i]perylene	10.5	1,1,2-Trichloroethane	5
1,3-Dichlorobenzene	10.5	Benzo[k]fluoranthene	10.5	1,1-Dichloroethane	5
1,4-Dichlorobenzene	10.5	Benzyl alcohol	10.5	1,1-Dichloroethene	5
2,4,5-Trichlorophenol	52.5	bis(2-Chloroethoxy) methane	10.5	1,2-Dichloroethane	5
2,4,6-Trichlorophenol	10.5	bis(2-Chloroethyl) ether	10.5	1,2-Dichloropropane	5
2,4-Dichlorophenol	10.5	bis(2-Chloroisopropyl) ether	10.5	2-Butanone	10
2,4-Dimethylphenol	10.5	bis(2-Ethylhexyl)phthalate	10.5	2-Chloroethylvinyl ether	10
2,4-Dinitrophenol	52.5	Butyl benzyl phthalate	10.5	2-Hexanone	10
2,4-Dinitrotoluene	10.5	Chrysene	10.5	4-Methyl-2-pentanone	10
2,6-Dinitrotoluene	10.5	di-n-Butylphthalate	10.5	Acetone	10
2-Chloronaphthalene	10.5	di-n-Octylphthalate	10.5	Benzene	5
2-Chlorophenol	10.5	Dibenzofuran	10.5	Bromodichloromethane	5
2-Methylnaphthalene	10.5	Dibenz[a,h]anthracene	10.5	Bromoform	5
2-Methylphenol	10.5	Diethylphthalate	10.5	Bromomethane	10
2-Nitroaniline	52.5	Dimethyl phthalate	10.5	Carbon tetrachloride	5
2-Nitrophenol	10.5	Fluoranthene	10.5	Chlorobenzene	5
3,3'-Dichlorobenzidine	21	Fluorene	10.5	Chloroethane	10
3-Nitroaniline	52.5	Hexachlorobenzene	10.5	Chloroform	5
4,6-Dinitro-2-methylphenol	52.5	Hexachlorobutadiene	10.5	Chloromethane	10
4-Bromophenyl-phenylether	10.5	Hexachlorocyclopentadiene	10.5	cis-1,3-Dichloropropene	5
4-Chloro-3-methylphenol	10.5	Hexachloroethane	10.5	Dibromochloromethane	5
4-Chloroaniline	10.5	Indeno[1,2,3-cd]pyrene	10.5	Ethylbenzene	5
4-Chlorophenyl phenyl ether	10.5	Isophorone	10.5	Methylene chloride	5
4-Methylphenol	10.5	N-Nitroso-di-n-propylamine	10.5	Styrene	5
4-Nitroaniline	52.5	N-nitrosodiphenylamine	10.5	Tetrachloroethene	5
4-Nitrophenol	52.5	Naphthalene	10.5	Toluene	5
Acenaphthene	10.5	Nitrobenzene	10.5	trans-1,2-Dichloroethene	5
Acenaphthylene	10.5	Pentachlorophenol	52.5	trans-1,3-Dichloropropene	5
Anthracene	10.5	Phenanthrene	10.5	Trichloroethene	5
Benzoic acid	52.5	Phenol	10.5	Vinyl Acetate	10
Benzo[a]anthracene	10.5	Pyrene	10.5	Vinyl chloride	10
Benzo[a]pyrene	10.5	1,1,1-Trichloroethane	5	Xylenes (total)	5

Table 4-3

Concentrations of TNT, TNB, RDX, and Total Nitrobodies (in µg/L) in the Test Groundwater

	TNT	TNB	RDX	Total Nitrobodies
Optimization Task - New TRW Well				
No. of Samples	13	13	13	13
Average	733	453	54.1	1624
Std Deviation	168	124	10.7	398
Median	692	456	52.0	1520
Range	517 - 1200	134 - 711	41.5 - 74.4	978 - 2570
Optimization Task - Well #66				
No. of Samples	9	9	9	9
Average	515	398	24.7	1083
Std Deviation	99	195	5.1	270
Median	508	461	27.6	1120
Range	335 - 645	114 - 711	14.4 - 29.7	755 - 1560
Demonstration Task Phase 1 - New TRW Well				
No. of Samples	93	93	93	93
Average	437	397	33.0	1005
Std Deviation	97	67	6.1	190
Median	423	395	32.9	972
Range	114 - 692	119 - 540	10.4 - 49.5	285 - 1470
Demonstration Task Phase 2 - New TRW Well				
No. of Samples	100	100	100	100
Average	312	346	22.5	758
Std Deviation	64	57	6.1	135
Median	297.5	336.5	21.8	729
Range	198 - 538	233 - 546	0.01 - 38.8	535 - 1200

4.5 SYSTEM DEBUGGING

4.5.1. Objectives

4.5.1.1. The objectives of this two-week task were as follows:

- Start up the demonstration plant
- Ensure that all its components were fully operational
- Calibrate all chemical feed systems
- Test all alarms and emergency shut-down systems
- Check for leaks and malfunctions.

4.5.1.2. A description of the tests that were conducted in this task is described below.

4.5.2 System Startup

4.5.2.1. Following the initial hydraulic testing done after construction was complete, tap water was pumped into the system at a flowrate of 25 gpm to fill up the six contactors with water.

4.5.2.2. The water was then adjusted to a flow rate of 10 gpm. The ozone system was turned on, and ozone was fed to the six contactors at 40 percent of capacity. Soap-Bubble tests were conducted on all gas-phase pipe connections outside the ozone generator, ozone monitor, and ozone destruction unit. While ozone was being fed to the system, the hydrogen peroxide feed system to the six contactors was turned on. The peroxide system was checked for any hydrogen peroxide leaks. Any leaks discovered in the ozone system or the hydrogen peroxide system resulted in shutdown and draining of the system, and the leaks were repaired. This test was repeated until both feed systems were void of detectable leaks.

4.5.2.3. After all system components were checked for leaks, tap water flow rate was increased gradually to 25 gpm, accompanied by a corresponding increase in the ozone generator setting and hydrogen peroxide feed rates to deliver the design doses of 330 mg/L ozone and 108 mg/L hydrogen peroxide. The system was operated under these conditions for a period of 30 minutes during which a final leak check was conducted on all system components. These procedures were repeated three times over a period of 2 days until all ozone and hydraulic leaks were corrected.

4.5.3 Equipment Calibration

4.5.3.1. The following instruments and monitoring equipment were calibrated during this task:

- Influent water flowmeter
- Hydrogen peroxide metering pumps
- Ozone monitor

4.5.3.2. Influent Water Flowmeter. The influent flow meter was calibrated with tap water using a 55-gallon polyethylene drum. A total of three (3) indicated flow rates were evaluated: 10, 18, and 25 gpm. A constant flow rate was allowed through the meter. The water was diverted from the effluent of the first contactor through a flexible hose to the drain. After 10 minutes of steady flow, the water was diverted into the 55-gallon calibration drum. Time was kept using a stopwatch until the 50 gallon mark was reached. The ratio of 50 gallons divided by the fill time (in minutes) constituted the actual flowrate value in gpm. This test was repeated in triplicate for each of the three flow rates. Once the calibration curve was developed, the "actual" flow rate, instead of the "indicated" flow rate, was used in all subsequent testing.

4.5.3.3. Hydrogen Peroxide Metering Pumps. Hydrogen peroxide metering pumps were calibrated according to the manufacturer's recommendation: the pump stroke was adjusted to a level that produced the desired output at an approximate speed setting of 60 percent. The output per stroke was then calculated by measuring the volume drawn from a 1-liter graduated cylinder over a 100-stroke period. This procedure was repeated for each pump. The approximate required pump setting during testing was set by calculating the pump stroke rate required to produce the desired output. This output was then verified with a 1-Liter graduated cylinder on a daily basis.

4.5.3.4. Ozone Monitor. The ozone monitor was factory-calibrated by the manufacturer at the beginning of the study.

4.5.4 Alarm Checks

4.5.4.1 The Peroxone treatment system contained several operational safety alarms, including the following:

- Low process flow alarm
- Overflow alarm on the first contactor
- Containment pad spill alarm
- Three chemical feed tank low-level alarms
- Ozone generator failure plant shutdown alarm
- Ozone destruct failure alarm
- Numerous ozone generator alarms.

4.5.4.2. All of the above alarms were checked prior to system startup.

4.5.5. Summary of Problems

4.5.5.1. During debugging, several minor problems were identified and corrected:

1. The influent gas lines to the contactors kept filling with water that backed up through the rotameters into the tubing; water almost flowed into the header piping. To remedy this problem the gas tubing was lengthened and run up above the top of the contactor to prevent water from backing up the tubing higher than the water level in the contactor vessel.

2. Several CPVC fittings on the off-gas analyzer tubing connections began to dissolve from contact with the ozone gas mixture. These were replaced with teflon or stainless steel fittings.

3. The metering pumps were inconsistent in flowrate. The problem was diagnosed as a loss in prime to the pumps. This was remedied by lowering the feed piping from the hydrogen peroxide day tanks and installing back-pressure control valves on the pump intake lines. This correction prevented a break in suction to the pumps, and prevented them from losing their prime.

4. The ozone generator had two failure episodes where the control panel showed a high DC voltage alarm. This problem was traced to the main power source which was delivered at 500 volts rather than the 480 volt service requested. The over-voltage burned out several components in the control panel which resulted in the need to bring a representative from the manufacturer to the site for repairs and calibration. Repairs were made and the inlet voltage was adjusted to a proper operating level within the DC transformer that fed the ozone generator vessel. Repairs to the generator were made 27 and 28 August 1996.

5. The north well pump (Well No. 66) kept shutting down with an overload. The motor starter was adjusted to a higher amperage trip-out and restarted. The pump ran without interruption, but the influent groundwater stream was filled with air bubbles after a few minutes of operation. The water level was checked in the well and it revealed that the well was not producing enough water to maintain a flow of 25 gpm as expected. The well was pressurized to improve the yield and the pump was lowered slightly. The remedy for this well was to reduce the flowrate to about 15 gpm to maintain a sustained flow.

6. The rotameters controlling the gas flow into the contactors were beginning to cloud up and could not be read easily. The acrylic bodies were not holding up to the concentration of ozone in the feed gas. This was remedied by replacing the original rotameters with glass-bodied units.

7. The gas flow into the contactors was not producing the fine bubble mist in the water that was anticipated. Closer inspection revealed that the manufacturer had sent the wrong kind of gaskets to seal the diffuser stones to the gas header in the contactors, and that two of the twelve stones were cracked and defective. This resulted in ozone leaking around the connections and forming

large bubbles in the tanks. The problem was remedied by replacing the defective stones and gaskets.

4.6 SYSTEM OPTIMIZATION

4.6.0.1. The objective of the system optimization phase was to run the Peroxone system under varying conditions of water source, water flow rate (i.e., varying reaction times), and ozone doses to determine the impact of these variable conditions on the destruction of TNT, TNB, RDX, and total nitrobodies through the system. The following is a discussion of the experimental conditions used and results obtained.

4.6.1 Experimental Conditions

4.6.1.1. The experimental conditions evaluated during the two-week optimization program are outlined in Table 4-4. A total of 10 tests were conducted. Six of these tests (Tests #1 through #4 and Tests #9 and #10) were conducted on New TRW Well water, while the remaining four tests (Tests #5 through #8) were conducted on Well #66 water. The flow rates tested were 13 gpm, 18 gpm, and 25 gpm, which equate to average hydraulic retention times (HRT) of 46 minutes, 33 minutes, and 24 minutes, respectively, in each of the six contactors. The total applied ozone dose ranged from a low of 228 mg/L (38 mg/L per contactor) to a high of 690 mg/L (115 mg/L per contactor). To achieve these doses, the percent ozone in the oxygen feed gas ranged from a low of 3.3 percent to a high of 10.5 percent. The applied ozone dose was varied by changing the ozone concentration in the feed gas while maintaining a constant feed gas flow rate. Note that the ozone generator was designed to deliver 55 mg/L ozone per contactor at 25 gpm flow rate. Therefore, in order to increase the applied ozone dose to greater than 55 mg/L, the water flow rate had to be decreased below its design value of 25 gpm, which in turn increased the HRT value through the contactors. Therefore, for ozone doses greater than 55 mg/L, two variables — ozone dose and contact time — had to be varied simultaneously, which is not ideal for an optimization testing program. Therefore, when analyzing the results of the study, it is important that comparisons be made between tests that differed by only one variable at a time.

4.6.1.2. As shown later in this report, two of the independent variables, hydrogen peroxide dose and water source, had little to no effect on the performance of the Peroxone process for explosives treatment within the range of values tested. The only two remaining independent variables were 1) water flow rate, and 2) ozone dose (which is a direct result of changing the percent ozone in the feed gas stream). Therefore, it was realized that simultaneously changing these variables during the optimization testing was not an ideal experimental approach. However, as mentioned above, the limitation of the ozone generator capacity forced the project team to lower the flow rate in order to achieve a higher ozone dose. In order to overcome this shortcoming, the project team relied on mathematical modeling as opposed to direct analysis of the results. Thus, an empirical mathematical model was developed specifically for this project. The model, which is presented and discussed later in this report, focused on both the ozone dose and the hydraulic behavior (including the water flow rate) in interpreting and sorting through all the results of the optimization and demonstration tasks. Once the model was calibrated with the experimental results, it was then used to optimize the design of the 1000-gpm facility. The project team believes that this approach eliminated the concern over the impact of simultaneous variation of the ozone dose and water flow rate through the system on the ability to interpret the experimental results.

4.6.1.3. During Tests #1 through #8, the hydrogen peroxide feed rate was varied with the ozone dose in order to maintain a mass Peroxone ratio of approximately 0.3 (i.e., 0.3 mg hydrogen peroxide per mg of ozone transferred to the water).[†] This ratio was based on the stoichiometry of reaction between ozone and hydrogen peroxide. However, the ozone residual concentration measured in the effluent of each contactor was substantially higher than expected (greater than 1 mg/L). Accordingly, the Peroxone ratio during Tests #9 and #10 had to be increased to approximately 0.54 and 0.47 respectively, in order to maintain the ozone residual in the effluent of each contactor at less than 1 mg/L. There is no explanation at this point as to why this ratio is significantly higher than the commonly used stoichiometric ratio of 0.3. However, it is important to note that the ozone doses

† All H_2O_2/O_3 ratios or Peroxone ratio presented in this report are based on a mass ratio of hydrogen peroxide dose to transferred ozone dose. A mass ratio of 0.3 mg/mg is equivalent to a molar ratio of 0.42 mole/mole.

used in this treatment system are almost two orders of magnitude higher than those used in conventional ozone applications in drinking water treatment, where the bulk of the industry's understanding of ozone/hydrogen peroxide reaction chemistry was developed. It is likely that the reactions at such high ozone doses may vary from those experienced at the low ozone doses, resulting in an increase in the optimum Peroxone ratio.

4.6.2 Experimental Results

4.6.2.1. The results obtained during the optimization period are listed in Appendix B.[2] The data show that TNB was the critical compound in that it was the most difficult to oxidize compared to TNT or RDX. Table 4-5 shows a summary of the results for New TRW Well. The objective of this table is to show the impact of ozone dose and HRT on the average percent removal of TNB through each of the six contactors. For example, Tests #1 and #10 had similar average transferred ozone doses to each contactor (within 10% difference). However, the contact time through each contactor in Test #10 was 46 minutes compared to 24 minutes in Test #1. Although the contact time was doubled while maintaining the same transferred ozone dose, the average percent removal only increased from 39 percent to 49 percent. This is primarily due to the fact that each contactor is completely mixed as will be shown and discussed later in this section. It is also noted that the ozone transfer efficiency varied from a low of 62% to a high of 82%.

4.6.2.2. On the other hand, comparison of Tests #4, #9, and #10 shows the impact of increased transferred ozone dose on TNB removal at a constant average HRT of 46 minutes through each contactor. As the dose was increased from 31 mg/L, to 42 mg/L, to 80 mg/L, the percent TNB removal increased from 36%, to 49%, to 62%, respectively.

[2] As noted earlier, the QA/QC results for explosives analysis are included in the Independent Evaluator's report for ESTCP titled: "Peroxone Demonstration: Performance and Cost Evaluation"

Table 4-4

Experimental Conditions Used During the System Optimization Program

Test #	Well	Flow gpm	HRT min	Total Applied O_3 Dose mg/L	Percent Ozone	H_2O_2 Dose mg/L	Peroxone Ratio* (mg/mg)
1	New TRW	25	24	360	10.1%	87	0.39
2	New TRW	18	33	390	7.9%	90	0.30
3	New TRW	18	33	510	10.2%	108	0.30
4	New TRW	13	46	690	10.5%	135	0.27
9	New TRW	13	46	228	3.3%	101	0.54
10	New TRW	13	46	336	4.9%	119	0.46
5	#66	18	33	258	5.5%	54	0.31
6	#66	18	33	390	7.9%	90	0.31
7	#66	18	33	510	10.2%	108	0.29
8	#66	13	46	690	10.5%	135	0.27

* The Peroxone Ratio is calculated as the ratio of hydrogen peroxide dose (in mg/L) to the transferred ozone dose (in mg/L)

Table 4-5

Summary of the Optimization Results for TNB Removal From New TRW Well Water

Test #	Ave. Transferred O_3 Dose/Chamber mg/L	Ozone Transfer Efficiency	Ave. HRT min	Average C_{eff}/C_{inf}	Average % TNB Removal
1	37	62%	24	0.61	39%
2	48	74%	33	0.62	38%
3	57	67%	33	0.35	65%
4	80	70%	46	0.38	62%
9	31	82%	46	0.64	36%
10	42	75%	46	0.51	49%

4.6.2.3. The results from Tests #2 and #3 are unusual in that the changes in TNB removal do not reflect the changes in the transferred ozone dose and/or hydraulic retention time. For example, comparing the operating conditions of Test #2 to those of Test #1 show an increase in the average transferred ozone dose from 37 mg/L to 48 mg/L per contactor with a parallel increase in the hydraulic contact time from 24 minutes to 33 minutes. However, there was no change in the average percent removal of TNB. Similarly, while the average transferred ozone dose and average contact time in Test #3 were significantly lower than those in Test #4, the average percent TNB removal was higher in Test #3. Examination of the raw data sheets from Tests #2 and #3 shows a substantial scatter in the TNB removal data, which may explain the observed anomalies in the summary results presented in Table 4-5.

4.6.2.4. These observations are important because they have direct implications to the design of the full-scale Peroxone treatment system. For example, based on the percent removals listed in Table 4-5, Table 4-6 lists various configurations of Peroxone treatment system required to achieve 99% removal of TNB. It is important to note that the configurations listed in Table 4-6 are simulated based on the average percent TNB removal observed during the optimization task.

4.6.2.5. Some interesting observations are made from the configurations listed in Table 4-6. The first and fourth configurations have virtually identical total hydraulic residence times, which means the same size contactor. However, increasing the number of chambers from five to nine, and reducing the contactor HRT from 46 minutes to 24 minutes, increased the contactor efficiency and reduced the required total transferred ozone dose from 400 mg/L to 333 mg/L, approximately 17% reduction in required ozone capacity.

4.6.2.6. Four optimization tests were also conducted on Well #66 water. The summary of these results are listed in Table 4-7. The results from Test #6 were highly scattered, and are thus not listed in Table 4-7.

Table 4-6

Simulated Peroxone Treatment System Configurations That Would be Required to Achieve 99% Removal of TNB

Number of Chambers	HRT/Chamber minutes	Total HRT hrs	Transf. Ozone Dose/Chamber mg/L	Total Transf. Ozone Dose, mg/L
9	24	3.6	37	333
10	46	7.7	31	310
7	46	5.4	42	294
5	46	3.8	80	400

Note: The values listed in this table were estimated based on linear extrapolation of the experimental results reported in Table 4-5.

Table 4-7

Summary of the Optimization Results for TNB Removal From Well #66 Water

Test #	Ave. Transferred O_3 Dose/Chamber mg/L	Ave. HRT min	Average C_{eff}/C_{inf}	Average % TNB Removal
5	27	33	0.82	18%
7	60	33	0.74	26%
8	80	46	0.38	62%

4.6.2.7. Due to the anomalies observed in Tests #2 and #3 during New TRW Well testing (as discussed earlier in paragraph 4.6.2.3), the results of Tests #5 and #7 cannot be reliably used to compare the performance of the Peroxone treatment system on Well #66 water to that on New TRW Well water. However, the operational conditions of Test #8 (i.e., transferred ozone dose and average contact time) using Well #66 water were similar to those of Test #4 using New TRW Well water. The corresponding TNB removal in the two waters was identical at 62%, suggesting that the performance of the Peroxone treatment system was independent of the water quality differences between New TRW Well and Well #66. It is interesting to note that the results suggest that the HRT had a more significant impact on TNB removal than the ozone dose.

4.7 SYSTEM DEMONSTRATION

4.7.0.1. Based on the results of the optimization testing, two sets of operating conditions were selected for the demonstration testing. In addition, after discussions with the various project members, it was decided that the demonstration testing was only to be conducted on New TRW Well water (due to its low yield, and the similarity in the Peroxone performance for explosives' oxidation in both waters).

4.7.1 Experimental Conditions

4.7.1.1. For the first four weeks of the demonstration period (Phase I), the Peroxone system was operated under conditions predetermined to achieve the target water quality goals of 0.002 mg/L of each of TNT, TNB, and RDX, and 0.3 mg/L of Total Nitrobodies. The operating conditions for Phase I demonstration testing are listed in Table 4-8.

During the second four weeks of the demonstration period (Phase II), the Peroxone system was operated at higher flowrate (i.e., lower contact time), and lower ozone dose than those used in Phase I. The experimental conditions for Phase II testing are also listed in Table 4-8. Based on the system optimization results, it was clear that the conditions used in Phase II were not going to achieve the target effluent concentrations. However, the project team decided to evaluate these conditions with the idea that a hybrid system of a PEROXONE process operated under these conditions followed by a GAC adsorption process for complete contaminants removal may actually be more cost effective than a PEROXONE process alone. However, it is noted that this approach does not address the possible formation of oxidation by-products which may consume the GAC capacity more rapidly. During Phases I and II testing, the ozone transfer efficiency was approximately 78% and 76%, respectively.

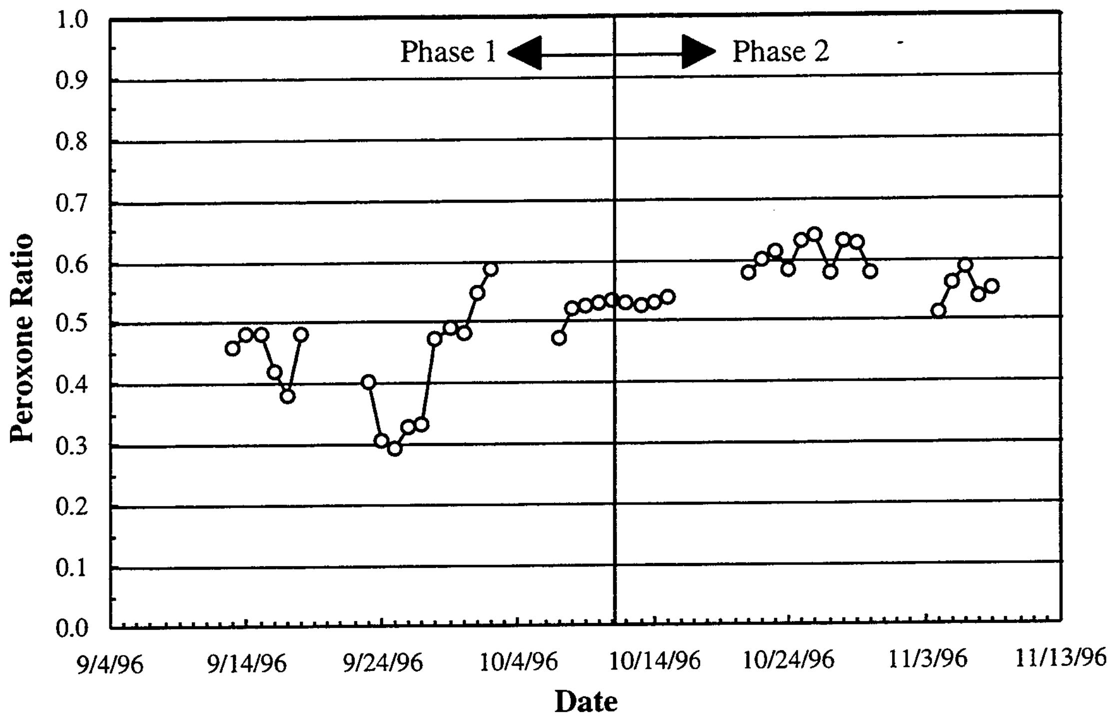
Table 4-8

Operating Conditions During Phases I and II of the Demonstration Testing Period

Parameter	Unit	Value	
		Phase I	Phase II
Well Number	—	New TRW	New TRW
Water Flowrate	gpm	13	25
Total Ave. Contact Time	hrs	4.6	2.4
Applied Ozone Dose	mg/L	100 (95 to 115)	58 (55 to 60)
Transferred Ozone Dose	mg/L	78 (72 to 92)	44 (42 to 47)
Transfer Efficiency	Percent	78%	76%
H_2O_2 Dose	mg/L	35 (24 to 46)	25 (24 to 28)
Peroxone Ratio	mg/mg	0.45 (0.29 to 0.59)	0.57 (0.51 to 0.64)

Note: numbers in parentheses represent minimum and maximum values.

4.7.1.2. It should be noted that the Peroxone mass ratio during Phase I of the demonstration period was increased from a low of 0.29 to a high of 0.59 mg/mg. This is due to the fact that when the demonstration period started, the target Peroxone ratio was still at 0.3 (as stated in the RFP documents). However, it was then decided that the hydrogen peroxide dose (and thus the Peroxone ratio) should be increased until the ozone residual concentration in the effluent of the contactors was at levels less than 1 mg/L. Accordingly, the average Peroxone ratio was increased to approximately 0.55. Figure 4-3 shows the profile of the average Peroxone ratio (among the six contactors) throughout the demonstration period.

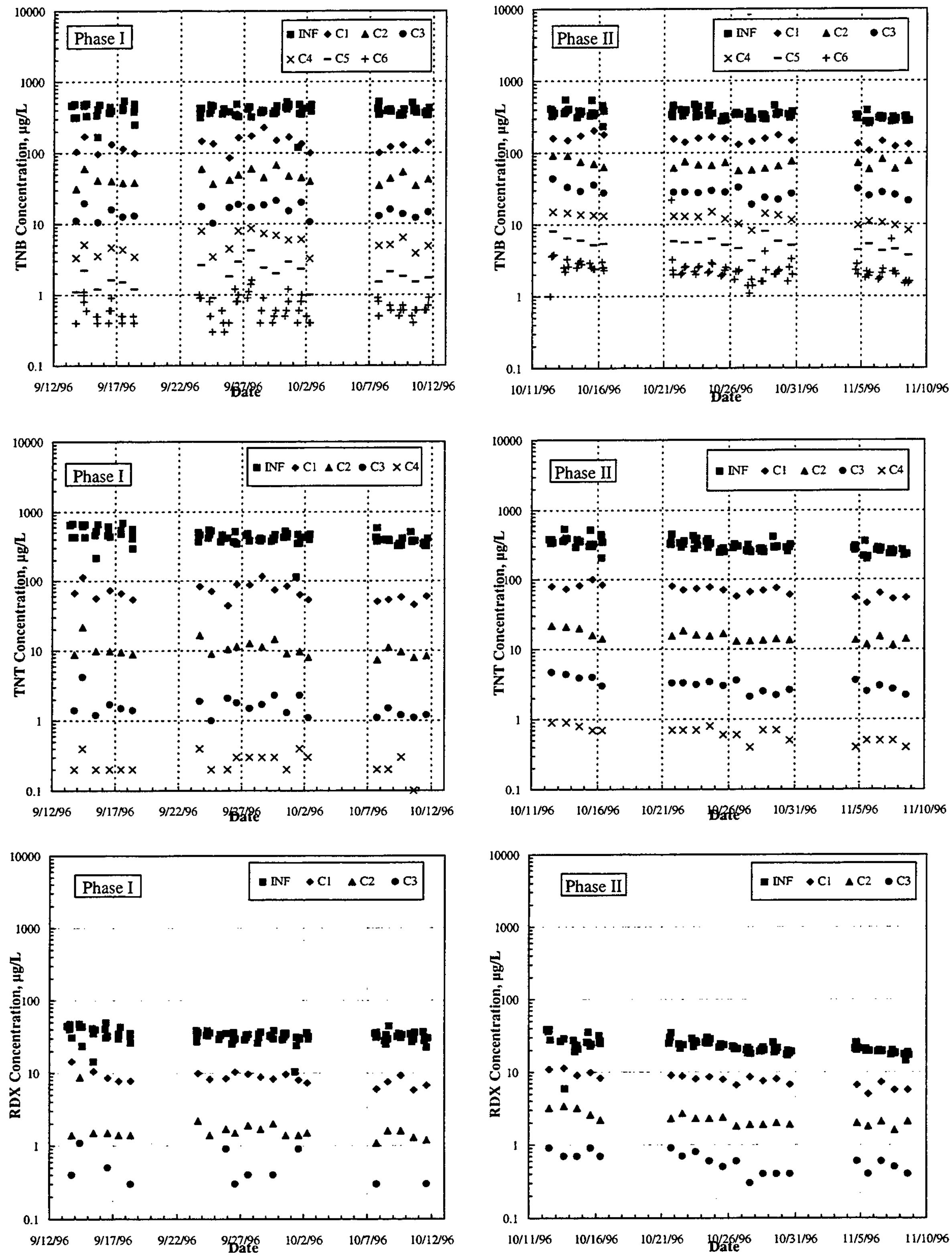


Peroxone Ratio During Phases 1 and 2 of the Demonstration Period

Figure 4-3

4.7.2 Experimental Results

4.7.2.1 Explosives Removal. The results of the demonstration period are summarized in Appendix C of this report. The data gathered during this period are shown graphically in Figure 4-4 for Phase I and Phase II of the demonstration period. The results show that with an average HRT of 4.6 hours and an average transferred ozone dose of 78 mg/L per contactor during Phase I of the demonstration period, all influent concentrations of TNT, TNB, and RDX were reduced to less than 2 µg/L in the effluent of the Peroxone treatment system, with TNB being the most difficult compound to remove. When the contact time and transferred ozone dose were reduced to 2.4 hrs and 44 mg/L, respectively (in Phase II), the effluent concentrations of TNT and RDX were still lower than the target level of 2 µg/L. The effluent concentration of TNB ranged from 2 to 4 µg/L. While this was higher than its target level of less than 2 µg/L, it represents significant removals considering the substantially lower ozone dose and contact time used. This result suggests that a hybrid system of a Peroxone process for partial contaminants removal followed by another



Performance of the PEROXONE Treatment System for the Removal of TNT, TNB, and RDX During Phase I and Phase II of the Demonstration Period

Figure 4-4

process (such as GAC adsorption) for final treatment may be more economically feasible than a stand-alone Peroxone process for complete treatment.

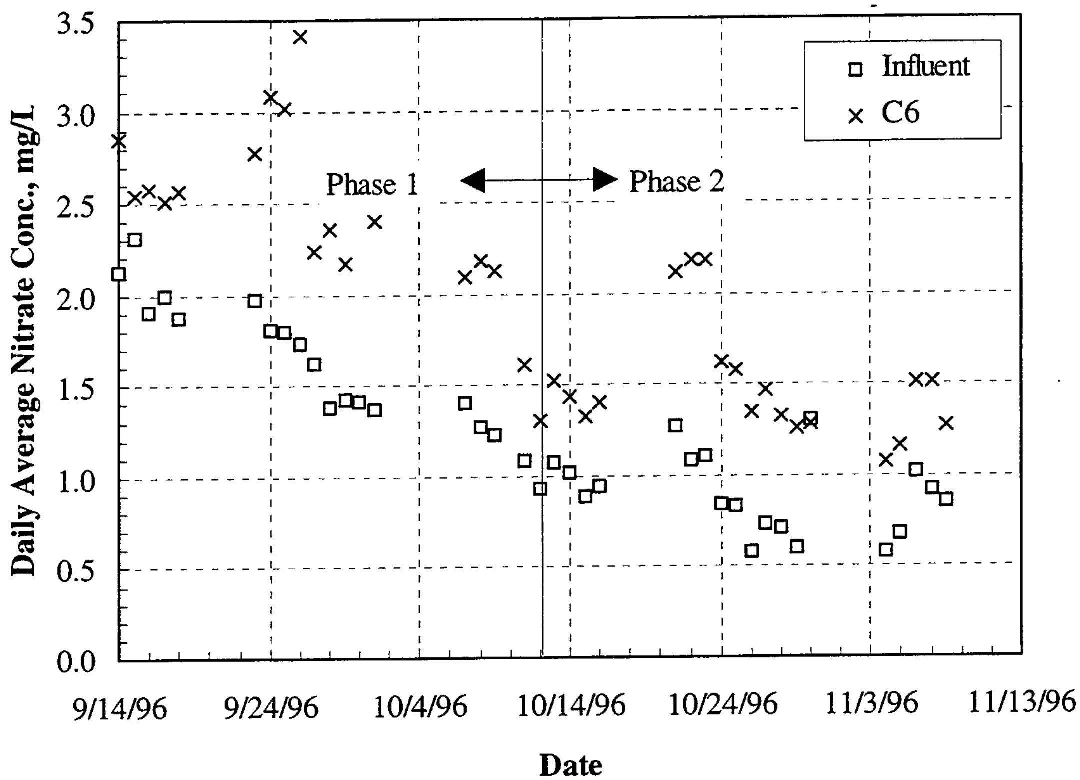
4.7.2.2. It is interesting to note that the removal of TNB (as well as the other compounds) did not substantially change throughout Phase I of the demonstration period, despite the fact that the Peroxone ratio increased from a low of 0.27 mg/mg to a high of 0.59 mg/mg. This suggests that the oxidation of the target contaminants was not limited by the concentration of hydroxyl radicals (or other highly reactive radicals) in the treatment process, but rather by the rate of reaction between these radicals and each of the target contaminants.

4.7.2.4. Nitrate Formation. The influent and effluent water to and from each contactor was also analyzed for nitrate concentration. The results of the nitrate analysis are shown in Figure 4-5 for the influent water and the last contactor (C6) effluent. The results clearly show an increase in the concentration of nitrate through the Peroxone treatment system. As a daily average value, the nitrate concentration increased by an average of 0.86 mg/L during Phase I testing period, and by 0.60 mg/L during Phase II testing period. It is clear that the higher ozone dose and contact time used during Phase I testing resulted in the higher formation of nitrate. There are two potential sources for the additional nitrate:

1. Oxidation of ammonia-nitrogen to nitrate-nitrogen via the following half-reaction:

$$NH_3 + 3H_2O \rightarrow NO_3^- + 9H^+ + 8e^-$$

2. Oxidation of the nitrogen in the organic nitrobodies (i.e., TNT, TNB, RDX, etc.) to nitrate.



Formation of Nitrate Through the Peroxone Treatment System

Figure 4-5

4.7.2.5. A few measurements were made of the ammonia concentration in the influent and effluent waters to and from the Peroxone treatment system. The average concentration of ammonia in New TRW Well water was 0.29 mg/L, whereas the average concentration of ammonia in the effluent of the treatment system was approximately 0.17 mg/L. This translates into an equivalent increase in nitrate concentration of approximately 0.44 mg/L. However, it should be noted that the influent and effluent ammonia measurements were not made on the same day, and therefore, the calculated ammonia removal may not be accurate. If it is assumed that all the ammonia (0.29 mg/L) was converted to nitrate, the corresponding increase in nitrate concentration would be estimated at 1.06 mg/L (see chemical half-reaction in paragraph 4.7.2.4). Therefore, the oxidation of ammonia-nitrogen to nitrate-nitrogen may account for the majority, if not all of the increase in nitrate concentration in the water (due to the high solubility of ammonia in water, no significant volatilization of ammonia is expected).

4.7.2.6. The complete oxidation of organic nitrobodies can convert the organic nitrogen into inorganic nitrate-nitrogen. Assuming that complete oxidation did occur in the Peroxone treatment system, an influent TNT concentration of 0.5 mg/L would result in the formation of 0.41 mg/L nitrate.[‡] Therefore, considering all the other organic nitrobodies in the influent water, the oxidation of the organic nitrogen to inorganic nitrate-nitrogen can also account for all of the measured increase in nitrate concentration. Therefore, no conclusion can be made regarding the exact source of nitrogen that was converted to nitrate.

4.7.2.7. pH & ORP Measurements. Daily samples were collected from the effluent of each of the six contactors and analyzed for pH and oxidation-reduction potential (ORP). The profiles of the pH in the influent and effluent of the Peroxone treatment system are shown in Figure 4-6. The results show that the average pH of the influent groundwater was between 6.5 and 7.0. As the water went through each of the six contactors, the pH increased to 7.1, 7.3, 7.5, 7.6, 7.8, and 7.9, respectively. No specific testing was conducted to determine the cause of the pH drift. It may be due to CO_2 stripping from the groundwater during treatment, or a result of the reaction between ozone and hydrogen peroxide. The ORP results are listed in Appendix C. In general the ORP of the water increased from an average of 400 mV in the influent water to approximately 900 mV in the effluent of the sixth contactor. This increase in the ORP level is expected considering the high doses of oxidants (ozone and hydrogen peroxide) added to the water.

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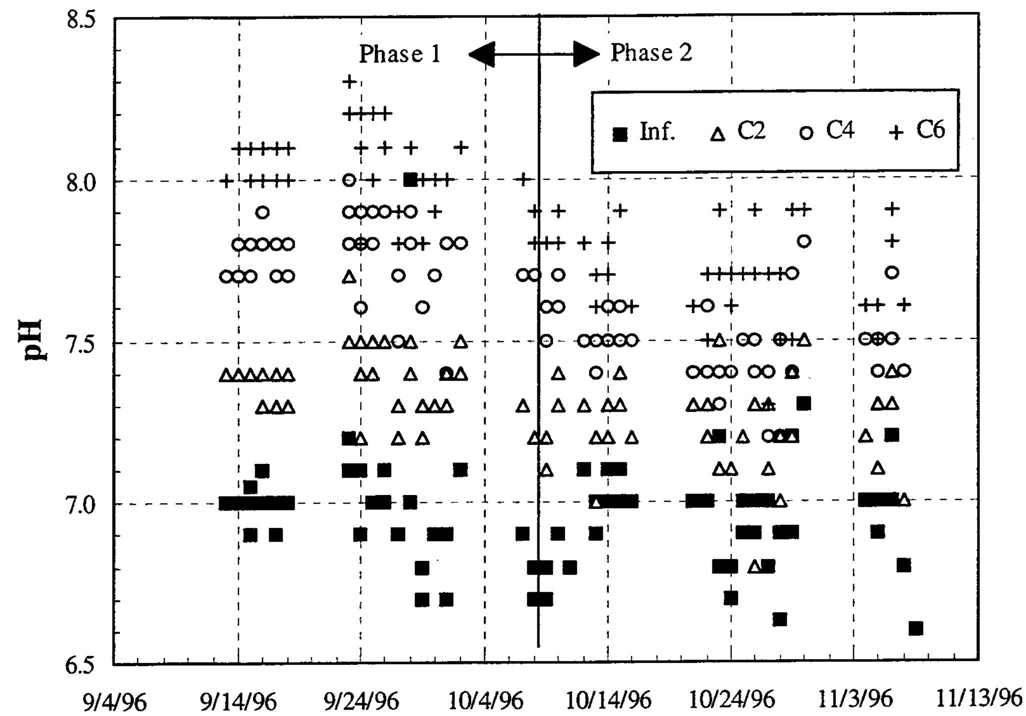
‡ $C_7H_5(NO_2)_3 + 17H_2O \rightarrow 3NO_3^- + 7CO_2 + 39H^+ + 36e^-$



Profile of pH in the Influent Water and Effluent Waters from Contactors #2, #4, and #6 During the Demonstration Period

Figure 4-6

4.8 FORMATION OF OZONATION BY-PRODUCTS

4.8.0.1. Ozonation of natural water is known to produce several inorganic and organic by-products. These include bromate (in bromide-containing waters), aldehydes, haloacetic acids, and other compounds. In order to determine the levels of ozonation by-products formed by the Peroxone process, two water samples were collected from the influent and effluent of the treatment system during Phase II of the demonstration period and analyzed for a wide range of organic compounds. The types and concentrations of the analyzed organic compounds in the two samples are listed in Table 4-9. The results show that, of the analyzed compounds, only one compound, formaldehyde at 11 μg/L, was present in the effluent of the Peroxone system. Considering that formaldehyde is highly biodegradable, however, it is anticipated that natural biodegradation of this compound will occur shortly after discharge of the treated water into the environment. Interestingly, trichlorotrifluoroethane (Freon) was measured at 66.3 μg/L in the New TRW Well water. However, this compound was removed by the treatment system to levels less than its detection limit of 0.5 μg/L.

4.8.0.2. It should also be noted that the influent and effluent samples were analyzed for total organic carbon (TOC) concentration. The influent water sample had a TOC concentration of 2.2 mg/L, whereas the effluent sample had a TOC concentration of 0.8 mg/L. This represents approximately 64% removal of the organic carbon. The removal mechanism is believed to include the oxidation of the organic carbon to inorganic carbon (i.e., CO_2) as a result of the extremely high ozone doses added to the system, and the formation of elevated levels of the highly reactive free radicals.

Table 4-9

Types and Levels of Organic Chemicals in the Influent and Effluent of the Peroxone Treatment System

	Level, μg/L			Level, μg/L	
Chemical	**Inf.**	**Eff.**	**Chemical**	**Inf.**	**Eff.**
Aldehydes:			Bromodichloromethane	<0.5	<0.5
Aetaldehyde	<1.0	<1.0	Benzene	<0.5	<0.5
Butanal	<1.0	<1.0	Bromobenzene	<0.5	<0.5
Formaldehyde	**<5.0**	**11**	Bromochloromethane	<0.5	<0.5
Glyoxal	<1.0	<1.0	Bromomethane	<0.5	<0.5
M-Glyoxal	<1.0	<1.0	cis-1,2-Dichloroethene	<0.5	<0.5
Pentanal	<1.0	<1.0	Chlorobenzene	<0.5	<0.5
Propanal	<1.0	<1.0	Carbon tetrachloride	<0.5	<0.5
Haloacetic Acids:			cis-1,2-Dichloropropene	<0.5	<0.5
Bromochloroacetic acid	<1.0	<1.0	Bromoform	<0.5	<0.5
Bromodichloroacetic acid	<1.0	<1.0	Chloroform	<0.5	<0.5
Chlorodibromoacetic acid	<1.0	<1.0	Chloroethane	<0.5	<0.5
Dibromoacetic acid	<1.0	<1.0	Chloromethane	<0.5	<0.5
Dichloroacetic acid	<1.0	<1.0	Dibromochloromethane	<0.5	<0.5
Monobromoacetic acid	<1.0	<1.0	1,2-Dibromo-3-Chloropropane	<1.0	<1.0

Table 4-9

Types and Levels of Organic Chemicals in the Influent and Effluent of the Peroxone Treatment System (Continued)

Chemical	Level, µg/L Inf.	Level, µg/L Eff.	Chemical	Level, µg/L Inf.	Level, µg/L Eff.
Monochloroacetic acid	<2.0	<2.0	Dibromomethane	<0.5	<0.5
Tribromoacetic acid	<1.0	<1.0	Dichlorodifluoromethane	<0.5	<0.5
Trichloroacetic acid	<1.0	<1.0	1,2-Dibromoethane	<0.5	<0.5
Volatile Organic Compounds:			Ethylbenzene	<0.5	<0.5
1,1,1,2-Tetrachloroethane	<0.5	<0.5	Hexachlorobutadiene	<0.5	<0.5
1,1,1-Trichloroethane	<0.5	<0.5	Isopropylbenzene	<0.5	<0.5
1,1,2,2-Tetrachloroethane	<0.5	<0.5	Methylene Chloride	<0.5	<0.5
1,1,2-Trichloroethane	<0.5	<0.5	m+p-Xylenes	<0.5	<0.5
1,1-Dichloroethane	<0.5	<0.5	Methyl tert-butyl ether	<5.0	<5.0
1,1-Dichloroethene	<0.5	<0.5	Naphthalene	<0.5	<0.5
1,1-Dichloropropene	<0.5	<0.5	n-Butylebenzene	<0.5	<0.5
1,2,3-Trichloropropane	<0.5	<0.5	n-Propylbenzene	<0.5	<0.5
1,2,4-Trichlorobenzene	<0.5	<0.5	Tetrachloroethene	<0.5	<0.5
1,2,4-Trimethylbenzene	<0.5	<0.5	p-Isopropyltoluene	<0.5	<0.5
1,3-Dichlorobenzene	<0.5	<0.5	sec-Butylbenzene	<0.5	<0.5
1,3-Dichloropropane	<0.5	<0.5	Styrene	<0.5	<0.5
1,4-Dichlorobenzene	<0.5	<0.5	trans-1,2-Dichloroethene	<0.5	<0.5
2,2-Dichloropropane	<0.5	<0.5	tert-Butylbenzene	<0.5	<0.5
2-Chlorotoluene	<0.5	<0.5	Trichloroethene	<0.5	<0.5
4-Chlorotoluene	<0.5	<0.5	**Trichlorotrifluoroethane**	**66.3**	**<0.5**
trans-1,3-Dichloropropene	<0.5	<0.5	Toluene	<0.5	<0.5
Trichlorofluoromethane	<0.5	<0.5	Vinyl Chloride	<0.3	<0.3

4.9 MATHEMATICAL MODELING

4.9.0.1. The scope of work for this project did not include the development of a mathematical model for the Peroxone treatment system. However, Montgomery Watson believes that such a model can be an effective tool for optimizing the design of any future large-scale Peroxone treatment system for the removal of TNT, TNB, and RDX from contaminated groundwaters. Such an optimized design results in a cost-effective treatment system.

4.9.1. Characterization of System Hydraulics (Tracer Testing)

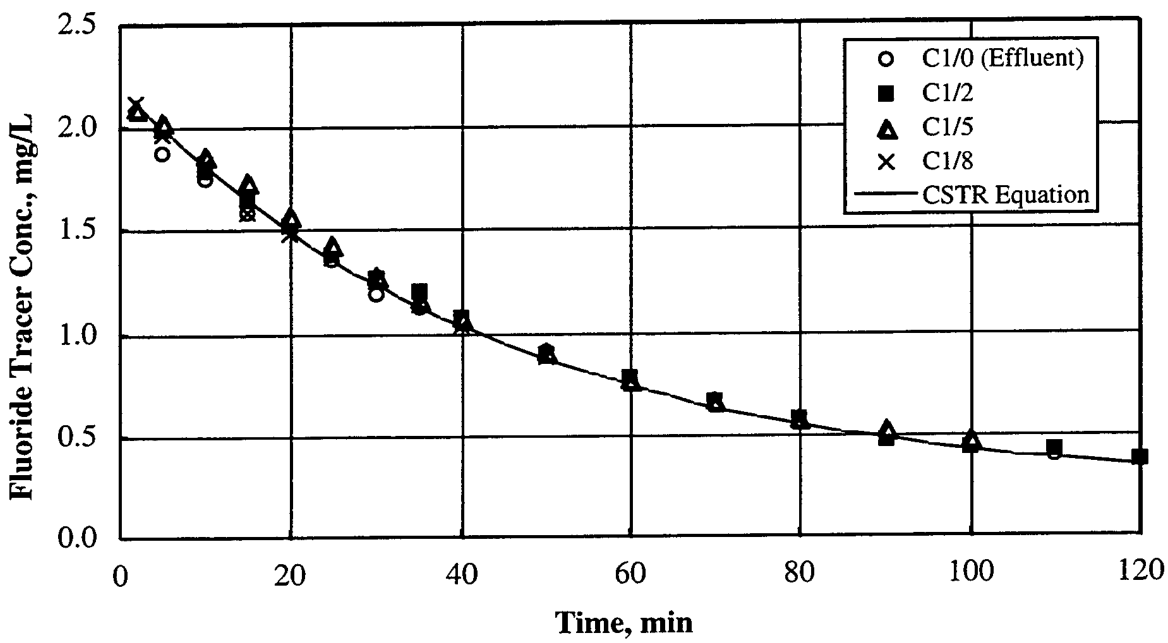
4.9.1.1. In order to develop a mathematical model for a continuous flow process, such as the Peroxone treatment system, it is imperative that the hydraulic residence time distribution of the system be fully characterized. This was accomplished by conducting two tracer tests on the first contactor at two water flowrates, 13 gpm and 25 gpm. The results of the tracer tests were then used to mathematically describe the hydraulic behavior of the Peroxone demonstration system.

4.9.1.2. Tracer Testing Methodology. Fluosilicic acid was used as the tracer chemical, with fluoride being the conservative tracer ion. A 25% Fluosilicic acid solution was purchased from VWR Scientific. A total of 22.3 grams of the tracer were diluted to 2 liters for both the 13 gpm test and the 25 gpm test. Based on a 79% fluoride content in Fluosilicic acid, the fluoride mass injected was 4.4 grams. The tracer solution was then injected through an injection port installed in the influent line to the first contactor, immediately before the water enters the top of the contactor. Tap water was pumped into the system during this test. The oxygen flowrate through the contactor was maintained at 1.5 scfm. However, no ozone was added to the influent stream in order to prevent possible interference with the fluoride analytical method.

4.9.1.3. At time zero, the tracer solution was injected into the influent water stream. Water samples were then collected from three taps along the depth of the first contactor (at 2 ft, 5 ft, and 8 ft from the bottom of the contactor), as well as from the effluent of the contactor at various time intervals. The sampling was continued over a period of time equivalent to three HRTs of the contactor. In addition, samples of the influent were collected throughout the testing period to obtain a good estimate of the background fluoride concentration in the water. Using an ion-selective electrode, all samples were analyzed on site for fluoride concentration.

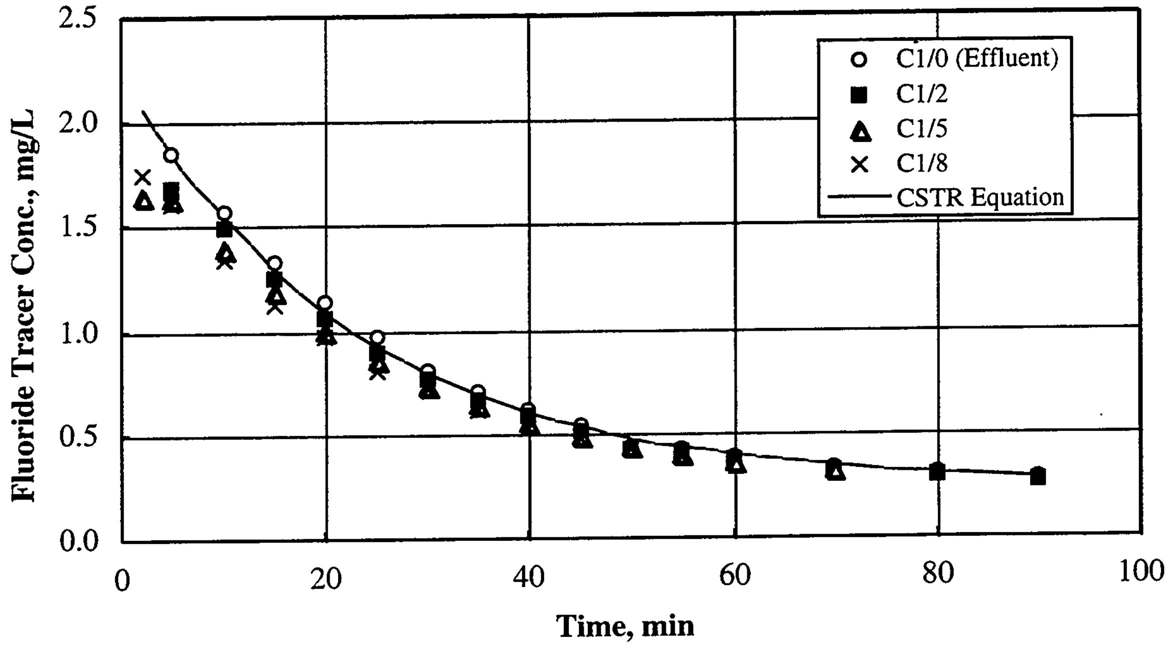
4.9.1.4. Tracer Testing Results

The results of the two tracer tests are shown in Figures 4-7 and 4-8. Overlayed on each graph is the theoretical tracer result that would be obtained if the contactor is simulated by a completely stirred tank reactor (CSTR) of equal hydraulic retention time. The CSTR model line is virtually on top of the experimental results obtained from all taps sampled. This shows that, for all practical purposes, each contactor in the Peroxone system behaved as a CSTR.



Tracer Test Results for a Flowrate of 13 gpm

Figure 4-7



Tracer Test Results for a Flowrate of 25 gpm

Figure 4-8

4.9.2. Model Development

4.9.2.1. With the hydraulic behavior of each contactor in the Peroxone system well characterized, a basic rate equation is required to complete the model development. Based on our experience with other oxidation reactions, a pseudo first-order reaction in explosive concentration as a function of time is a likely representation for the destruction of each of TNT, TNB, and RDX in the Peroxone system. In addition, the reaction rate constant is assumed to be proportional to the transferred ozone dose. Therefore, the resulting rate equation is expressed as follows:

$$rate = \frac{dC}{dt} = -k\,D^{m}\,C \qquad (4\text{-}1)$$

where, k = basic reaction coefficient, $(mg/L)^{-m}\,(min)^{-1}$,

m = empirical constant,

D = transferred ozone dose, mg/L, and

C = concentration of target contaminant, µg/L (i.e., TNT, TNB, or RDX)

4.9.2.2. The mass balance equation on a CSTR operating under steady-state conditions is:

$$C_{inf} - C_{eff} + (rate)\,\tau = 0 \qquad (4\text{-}2)$$

where, C_{inf} = influent contaminant concentration, µg/L,

C_{eff} = effluent contaminant concentration, µg/L,

τ = average hydraulic retention time in the contactor, minutes.

4.9.2.3. Substituting Equation 4-1 into Equation 4-2, and deriving an expression for C_{eff} gives Equation 4-3 describing the performance of each of the six contactors in the Peroxone system:

$$C_{eff} = \frac{C_{\text{inf}}}{\left(1 + k\,D^{m}\,\tau\right)} \qquad (4\text{-}3)$$

4.9.2.4. This model suggests that the effluent concentration of TNT, TNB, or RDX from any of the six contactors can be calculated if its influent concentration is known, along with the transferred ozone dose to the contactor, the contactor average hydraulic retention time, and the two model constants, k and m.

4.9.3 Calibration of Model Parameters

4.9.3.1. In the design of a full-scale system, all model parameters are known except for the basic reaction coefficient 'k' and the empirical constant 'm'. Therefore, the experimental results obtained during the optimization and demonstration testing programs were used to estimate the values of 'k' and 'm' for each of TNT, TNB, and RDX in the Peroxone process.

4.9.3.2. To achieve this, all the experimental results obtained in this project were tabulated. The data included the following parameters:

- Water flow rate
- Average hydraulic retention time through each contactor
- Transferred ozone dose to each contactor
- Measured influent concentration of TNT, TNB, and RDX to each contactor
- Measured effluent concentration of TNT, TNB, and RDX from each contactor.

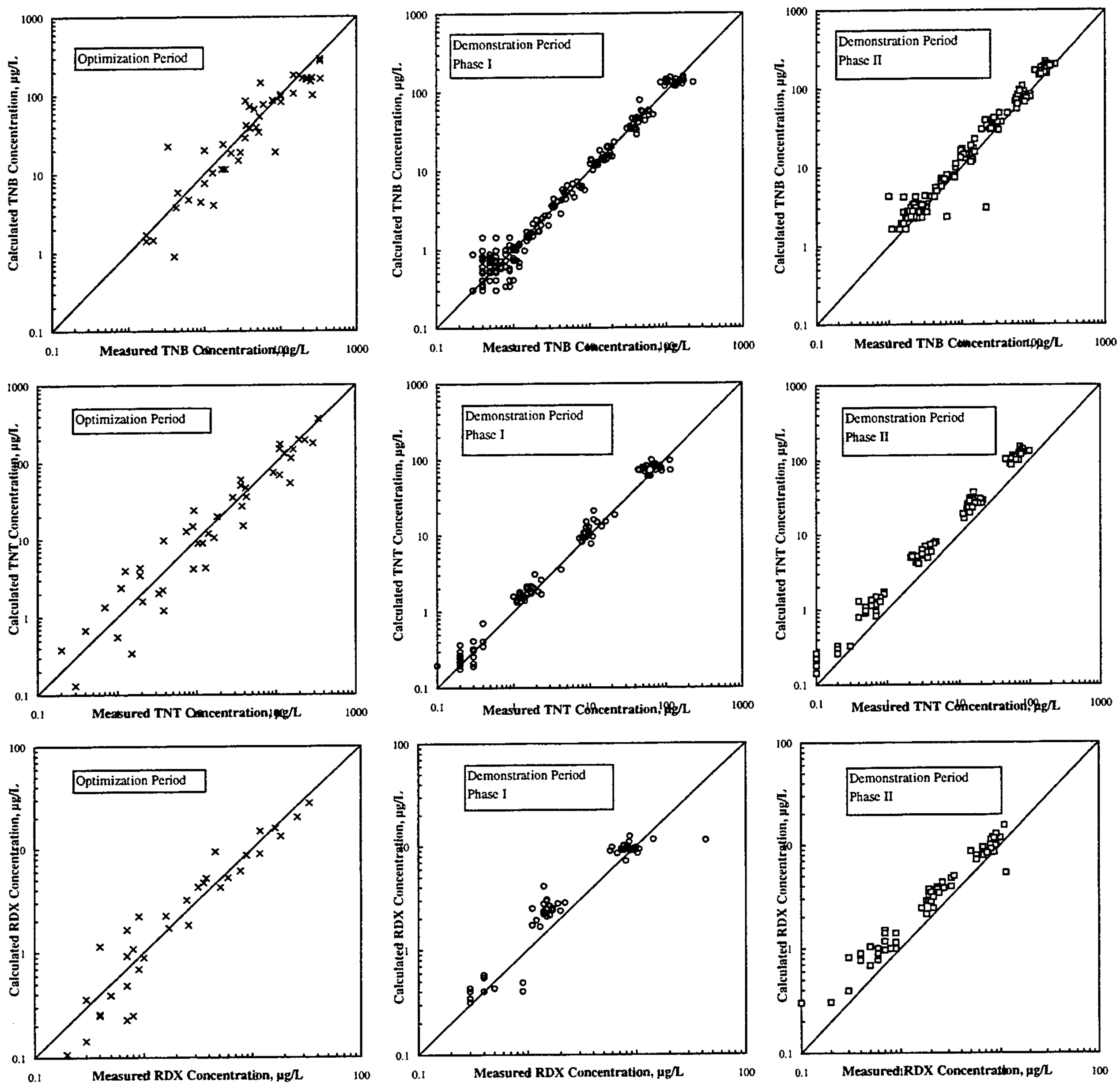
4.9.3.3. Using the values of the transferred ozone dose, hydraulic retention time, and influent contaminant concentration, Equation 4-3 was used to calculate the effluent concentration of TNT, TNB, and RDX for an assumed value of the basic reaction coefficient, k, and the empirical constant, m, for each compound. The calculated concentrations were then compared to the measured values. Using the SOLVER macro in Microsoft EXCEL, the optimum k and m values resulting in the minimum sum of the square of the error between the calculated and measured concentrations were determined for each contaminant. These values are listed in Table 4-10. It is important to note that these values are only applicable to the destruction of TNT, TNB, and RDX in Grand Island groundwater, and may vary significantly with changes in water quality and water source.

Table 4-10

Estimated Values of the Basic Reaction Rate Constants and Empirical Constants for the Oxidation of TNT, TNB, and RDX with Peroxone

Compound	k	m
TNB	0.0152	0.237
TNT	0.00569	0.662
RDX	0.0544	0.000

4.9.3.4. The quality of fit between the calculated concentrations (using the proposed model), and the measured concentrations from the effluent of each of the six contactors during the optimization and demonstration period are shown in Figure 4-9. The lines in Figure 4-9 are not linear regression lines through the data, but rather the "perfect fit"



Comparison Between Measured and Model-Calculated Concentrations of TNB, TNT, and RDX During the Optimization Period and the Demonstration Period

Figure 4-9

lines. In other words, the lines represent the ideal situation where the model-calculated values are equal to the measured values. If all the data points fall on the "perfect fit" lines, then the model is considered to be the "perfect" model to represent these data.

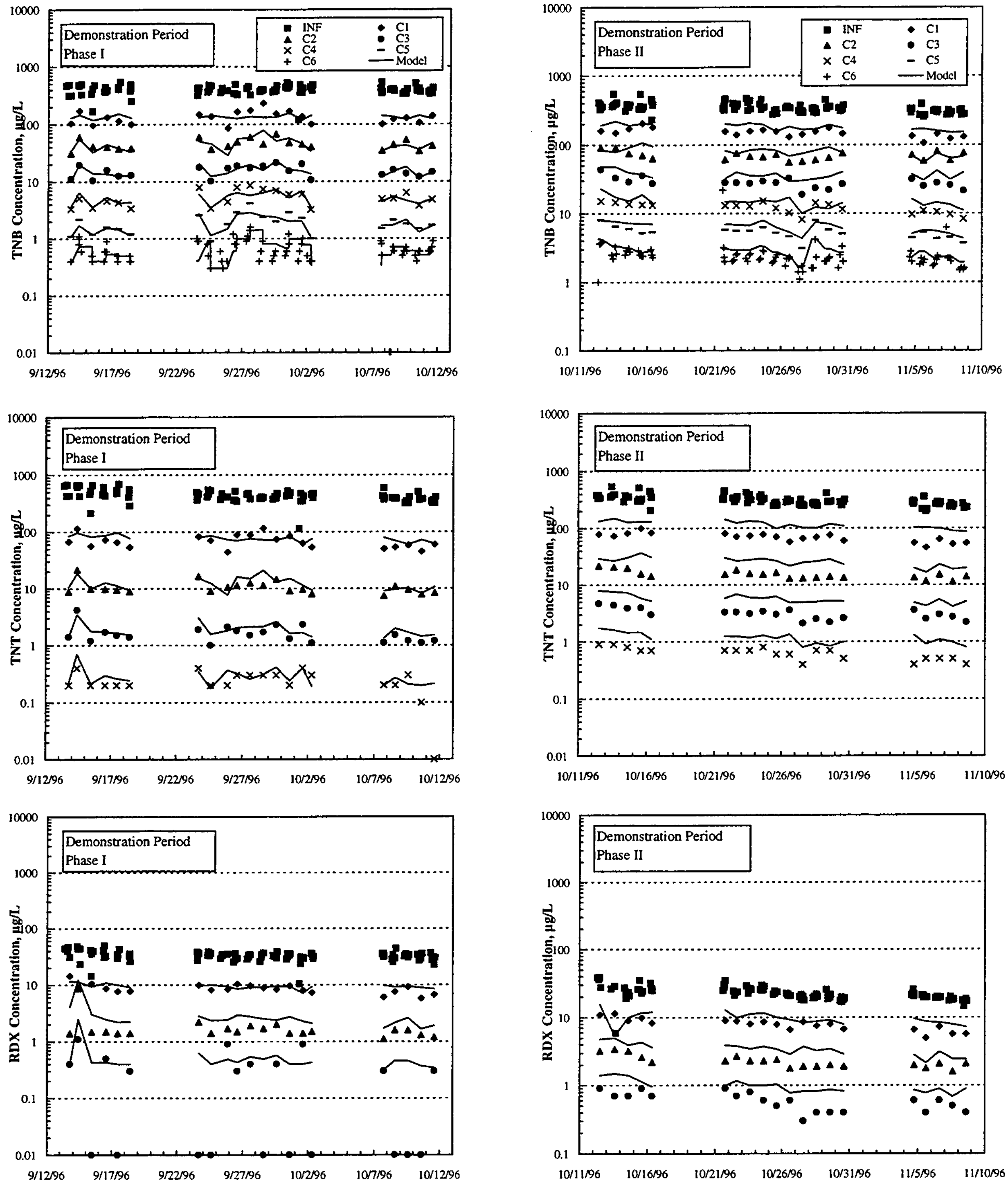
4.9.3.5. The model fit to the results of the demonstration testing is also presented in Figure 4-10 as plots of measured concentrations and model-calculated concentrations as a function of time. These graphs also show that the model was able to well represent the removal of TNB, TNT, and RDX during Phase I of the demonstration period, as well as that of TNB during Phase II of the demonstration period. However, the graphs show that the model underestimated the removal of TNT and RDX during Phase II of the demonstration period.

4.9.3.6. No explanation for this underestimation can be given at this time. Nevertheless, the model is still a useful tool for the design of larger scale Peroxone treatment systems for the following reasons:

- The model well predicted the removal of the critical design compound, TNB, in all the tests conducted at the various contact times and ozone doses

- The use of the model for TNT and RDX removal would, in the worst case, result in a conservative design, thus maintaining the required removals of these compounds.

4.9.3.7. It should be noted that the value of the empirical constant 'm' for RDX was estimated by the model at zero suggesting that RDX removal through the Peroxone process is independent of ozone dose. This is clearly not realistic since the removal efficiency of all compounds increased with increasing ozone dose. This model behavior is primarily due to the lack of sufficient high-concentration RDX data for a wide range of ozone doses and contact times (all RDX data are below 40 μg/L in the optimization testing, and below 16 μg/L in the demonstration testing compared to greater than 250 μg/L for TNT and TNB).



Model Fit to the Measured Concentrations of TNB, TNT, and RDX During Phase I and II of the Demonstration Period

Figure 4-10

4.9.3.8. The plots presented above in Figure 4-9 show some scatter around the perfect-fit lines. This scatter is due to several known and unknown factors involved in experimental work and mathematical modeling such as the following:

Experimental Errors. In any field (or laboratory) testing program, experimental errors are inevitable. These include errors in the measurement of operational parameters such as water flowrate, air flowrate, ozone dose, hydrogen peroxide dose, etc.

Analytical errors. All field and laboratory analyses conducted on the project include some level of analytical error that is attributed to instrument calibration, analytical technique, etc.

Variations in the Influent Concentrations of the Target Contaminants. Significant variations were measured in the groundwater concentrations of TNT, TNB, and RDX. Since the model is based on calculating the effluent concentrations as a function of the influent concentrations, these variations in the groundwater concentration levels have a direct impact on the model's ability to accurately predict the effluent concentrations. It is noted that, in the calibration of the model, the average groundwater concentrations measured during each test were used as the influent concentrations to the first contactor.

Empirical Nature of the Model. The model was developed empirically, and is not based on any known fundamental chemical reactions between the target contaminants, natural constituents of the groundwater, and the various oxidants produced as a result of the reaction of ozone with hydrogen peroxide. Therefore, it is understandable that the model will not predict the "exact" effluent concentration of each contaminant under all conditions.

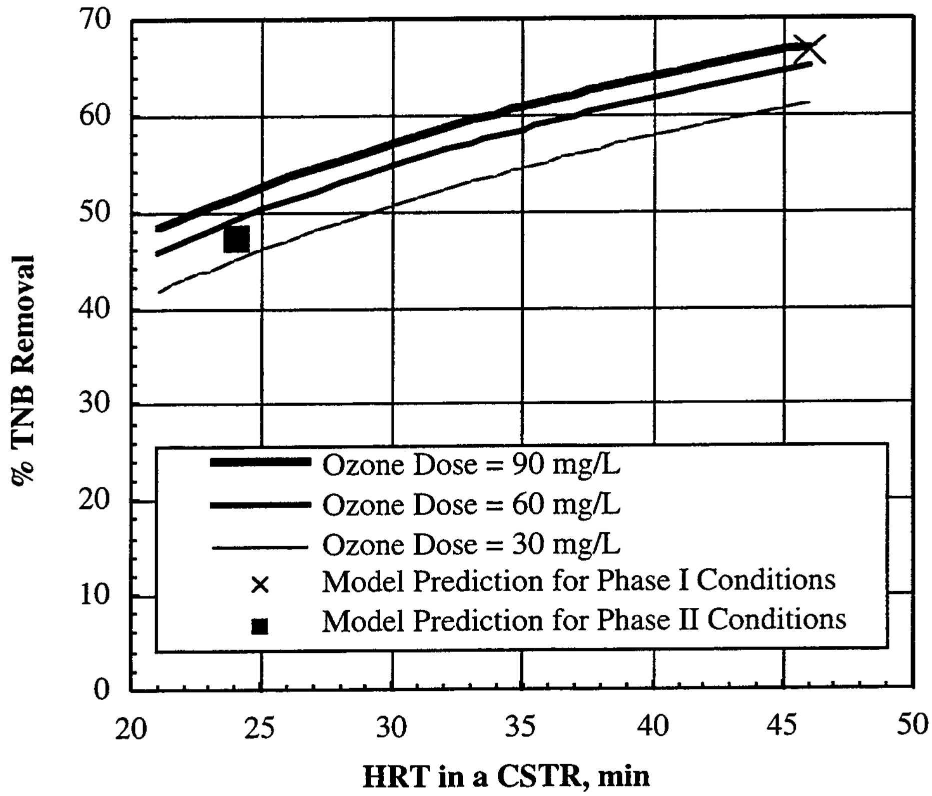
Nonideal Hydraulic Flow Regimes in the Contactors. Based on the two tracer tests conducted, each contactor was modeled as a CSTR. However, ideal mixing conditions are only theoretical. Therefore, there is always some variation between the actual hydraulic conditions in the contactor and those in an "ideally" mixed contactor. These variations can result in slight discrepancies in the model predictions.

4.9.3.9 It is important to note that the proposed model is purely empricial and is not based on any fundamental analysis of the chemical reactions taking place in this process. Therefore, the model should be used with caution and should not be extrapolated to operating conditions (i.e., ozone dose and hydraulic retention times) outside the limits of the conditions used in this project. In addition, the performance of the Peroxone process is highly dependent on water quality. Therefore, the estimated model parameters can only be used to estimate the removal of TNT, TNB, and RDX from the Grand Island groundwater, and should not be extrapolated to other waters.

4.9.4 Sensitivity Analysis

4.9.4.1 Figure 4-11 shows a model sensitivity plot depicting the model-calculated percent TNB removal with the Peroxone process in one contactor as a function of the HRT and transferred ozone dose in that contactor. The plot clearly shows that the process performance, as interpreted by the proposed model, has low sensitivity to either dose or HRT. In other words, the plot suggests that substantial increases in either ozone dose or HRT would result in small increases in % TNB removal. This is more apparent with the impact of the ozone dose on TNB removal where an increase from 60 mg/L to 90 mg/L (a 50% increase in dose) resulted in a modest increase of only 2% removal of TNB through the contactor.

4.9.4.2 The above analysis explains the difference in performance between Phase I and Phase II testing conditions. To illustrate this difference, the predicted percent TNB removals under each set of conditions are superimposed on Figure 4-11. Due to the low sensitivity of the process to either ozone dose and HRT, the model shows that increasing the ozone dose from 44 mg/L (Phase II) to 78 mg/L (Phase I), and increasing the contact time from 24 minutes (Phase II) to 46 minutes (Phase I) would result in an increase in the percent TNB removal from 47% (Phase II) to 66% (Phase I).



Impact of HRT and Transferred Ozone Dose on the Percent Removal of TNB in Each Contactor as Predicted by the Proposed Empirical Model

Figure 4-11

4.10 IMPLICATIONS FOR DESIGN

4.10.0.1. The results of the demonstration testing program have shown that TNT, TNB, and RDX can be removed from contaminated waters with the Peroxone treatment system, with TNB being the critical compound for the determination of the design criteria (i.e., most difficult to oxidize). The availability of a mathematical model for the Peroxone system provides an additional tool for design of the planned 1,000 gpm treatment system. With this simple model, design engineers can quickly simulate various conditions of influent concentrations, hydraulic retention times (i.e., treatment system sizes), and ozone doses and determine initial configurations of the full-scale system for the treatment of TNT, TNB, and RDX to desired effluent quality. Section 6.0 presents a proposed design configuration for the full-scale Peroxone treatment system.

5.0 PEROXONE SYSTEM DEMOBILIZATION

5.1 REVISION TO WORK PLANS

5.1.0.1. The Work Plans (Montgomery Watson, 1996) for this project called for shutdown and dismantling of the Peroxone treatment system after completion of the demonstration period. Each of the reactors was to be disconnected and shipped to a US Army storage facility to be named after shutdown. The pumps, mixers, electronic instruments, and control panels were to be warehoused at CAAP. The remaining equipment that was leased or rented would be returned and the piping, wiring, and power lines would be torn up and hauled away as scrap. The concrete pad would then be broken up and hauled to the landfill.

5.1.0.1. At the conclusion of the demonstration period, however, it was decided by USAEC that the system would be useful for further testing in the near future. Therefore, the contactors and the connecting piping were left in place, and only the equipment that may be weather sensitive was removed and warehoused.

5.2 SHUTDOWN

5.2.0.1. The demonstration period was completed 8 November 1996. After the last gallon of groundwater was treated through the system, the well pumps were turned off and clean water from the hydrant was diverted into the system to flush the contactors clean. The hydrogen peroxide feed pumps were shut off and the sodium thiosulfate feed system was also turned off. The ozone generator was shut down when flow from the wells was stopped, and the lines were purged with oxygen from the oxygen feed system. After several hours of flow with clean water, the water was shut off and the contactor tanks were shut down. Each of the contactor tanks was drained into the pad and pumped from the sump into the effluent tank. After all the contactors were emptied, the hydrogen peroxide day tanks were emptied and rinsed. The softened water tank was also emptied as was the sodium thiosulfate tank. All tanks were rinsed and all water was collected and pumped through the carbon vessels for final treatment. The piping on the pad was drained and anything that was subject to freeze damage was drained.

5.2.0.2. The system was turned off just before a cold front moved into the Grand Island Area on 10 November 1996. Though the treatment system had been shut down and drained, some water was still in the 2-inch conveyance lines from the wells and froze before the lines could be drained. The well pumps were removed and all valves were opened to allow drainage back into the wells when the lines thawed.

5.3 DECOMMISSIONING

5.3.0.1. To decommission the facility, the water supply was shut down, the power was turned off and disconnected, the unused chemicals were returned to the respective suppliers, the telephone was disconnected, and the office trailer was hauled away. All local utilities were notified that the site was closed.

5.4 DISMANTLING AND STORAGE

5.4.0.1. As discussed above, the Army decided to leave the treatment system at the CAAP for possible future use. It was decided that the contactors, tanks, and the secondary containment pad would remain in place. The demobilization efforts changed from complete dismantling and storage of the system to removal and storage of pumps, motors, electronics and return of rented equipment. The two well pumps, seven chemical feed pumps, mixers, meters, sump pump, transfer pump, hoses, effluent pump, and calibration equipment were all stored at the Cornhusker Facility in Building S-6 under the direction of Tom Jamieson, the Facility Administrator. Table 5-1 shows a list of items stored.

5.4.0.2. The contactors, piping, tanks, tubing, valves, and equipment supports were left in place on the pad. All tanks were drained prior to leaving the site.

5.4.0.3. The ozone generator was dismantled, crated, and shipped back to the leasing company with the control panel, the ozone destruct unit and the small air compressor used as a nitrogen source. The reverse osmosis unit was likewise returned, and the carbon vessels were drained and sampled. The GAC was tested by the vendor (Calgon Carbon) and was determined to be nonhazardous. The GAC was transported to the Laidlaw landfill in Utah (RCRA subtitle C landfill). The remaining equipment was kept inside a fenced, locked area around the Line 2 assembly buildings.

Table 5-1

Stored Equipment Inventory

Item	Quantity
Rotameters and stainless steel connection piping	6
Box of wire	1
Little Giant sump pump with level switch	1
LMI chemical metering pumps	7
2 inch in-line static mixer	1
1/2 inch glass rotameter	1
Effluent pump	1
Paddlewheel flow meters (Signet)	2
Extraction well pumps (Grundfos)	2
Buckets (2.5 gallons)	7
10 ft. long by 2 in. dia. flexible hoses (camlock)	2
Fire hydrant backflow preventer attachment	1
Bubble wrap packing in boxes	12
Broom	1
Mop	1
Garden Hoses (50 ft.)	2
Trailer power cord - 4 conductor, 100 ft.	1
20 ft. braided stainless steel hose 1 in. dia.	1
3/8" copper tubing - 25 ft.	1
Buckets (5 gallons)	2
3/8" plastic tubing - 25 ft	1
Box of miscellaneous CPVC fittings	1
Hand operated drum pump	1
Electric Mixers	3
Lab Equipment, boxes/containers	5

6.0 DEVELOPMENT OF FULL-SCALE PEROXONE SYSTEM

6.1 INTRODUCTION

6.1.0.1. This section discusses the recommendations for a full-scale Peroxone system based on the results of the demonstration testing program. The full-scale system developed and presented in this section is based on the Peroxone technology tested at the CAAP. No effort was made to evaluate alternative designs such as baffled or packed-bed contactors, using ozone bubble recombination, or other diffuser types or to evaluate the Peroxone technology in combination with other technologies (such as UV/ozone and GAC technologies) for a more economical treatment of explosives-contaminated groundwater.

6.1.0.2. A conceptual Process Flow Diagram (PFD) and preliminary capital and operations and maintenance (O&M) cost estimates for the recommended full-scale system are included.

6.1.0.3. As part of this effort, computer simulations and input from equipment vendors were used to determine the optimum treatment system with respect to performance, capital cost, operational cost, flexibility, and ease of operation.

6.2 SYSTEM SCALE-UP AND DEVELOPMENT PROCESS

6.2.0.1. The scale-up and development effort can be categorized as a five-step process outlined below. Each step is described in detail later in this section.

(1) Scale up of the Peroxone contactors to 1,000 gpm capacity.

(2) Use the Peroxone model developed in Section 4.0 to conduct computer simulations for a full-scale system (1,000 gpm flow rate per the Contract requirements).

(3) Evaluate the system configurations generated from the model simulations for technical feasibility, cost effectiveness, and ease of system operation and maintenance.

(4) Select a configuration for the full-scale design.

(5) Present preliminary capital and O&M cost estimates for the selected system.

6.2.1. Model Limitations

6.2.1.1. The Peroxone system model (Section 4.0) was used in the scale-up process as a tool which allowed for a quick relative comparison of numerous reactor configurations and oxidant doses. It is not intended to serve as the only tool for design of a full-scale system. The model is reliable within the boundary conditions which include the reaction kinetic parameters, contaminant type and concentration range, minimum and maximum applied ozone dosage, ozone transfer efficiency, and hydrogen peroxide dosage based on the Peroxone ratio. However, like other empirical models, there is little certainty in the accuracy and reliability of the model under conditions that are outside the boundary conditions of the data used to calibrate the model.

6.3 CONTACTOR SCALE UP

6.3.0.1. The contactor vessel used for the demonstration testing was a cylindrical tank 3 feet in diameter with a 10-foot side wall depth. It was determined through tracer testing that each contactor was completely mixed and that it acted as a continuously stirred tank reactor (CSTR).

6.3.0.2. Effluent sampling and analyses from individual contactors showed that all contactors provided approximately equal percent destruction of contaminants indicating that the contactor design was independent of the influent concentrations or oxidation chemical doses. Equal percent destruction in all contactors suggests that each contactor can be considered as a single CSTR for the purpose of the system design and scale up.

6.3.0.3. Assuming that contactors for the full-scale system can be considered as CSTRs, and that the number of CSTRs per contactor equals one, the contactor scale-up process simply involves selecting cylindrical tanks with diameter to side wall depth ratios similar to those provided for the demonstration testing. It is noted that preliminary cost analysis showed that the cost of utilizing cylindrical tanks for the 1000 gpm plant was comparable to that of a concrete contactor with multiple chambers. Therefore, the use of cylindrical steel tanks is not necessarily a recommendation at this time, but only an option for cost estimation purposes.

6.3.0.4. The initially selected tank diameter varied from 4 feet to 12 feet while the side wall depths ranged from 12 feet to 36 feet. Each combination was evaluated for holding capacity, ozone transfer efficiency (assumed at 90%), number of tanks required for 1,000 gpm system, and area requirements to hold the required number of tanks for a full-scale system. The evaluation showed that selection of tanks with a diameter less than 6 feet would necessitate too many tanks for a 1,000 gpm system and cause excessive head loss in the system. Thus, tanks with a diameter less than 6 feet were deleted from evaluation.

6.3.0.5. Montgomery Watson's experience suggests that no appreciable mass transfer between ozone and the liquid phase is realized beyond 23- to 25-foot side wall depth. In order to maintain a minimum side wall depth to diameter ratio of 3, this meant eliminating all tanks with side wall depth greater than 25 or a diameter greater than 8 feet.

6.3.0.6. Tanks passing the initial selection criteria included those with diameter between 6 and 8 feet and side wall depths ranging between 18 and 25 feet, and were retained for the simulation process. Table 6-1 shows the tank combinations that were used for computer simulations.

Table 6-1
Selected Tank Configurations

Tank Diameter (feet)	Side Wall Depth (feet)
6	18
6	19
6	20
6	21
6	22
6	23
6	24
6	25
7	21
7	22
7	23
7	24
7	25
8	24
8	25

6.4 PEROXONE MODEL SIMULATIONS

6.4.1. Model Development

6.4.1.1. For each simulation, the total flow to the system was fixed at 1,000 gpm and the influent concentrations were assumed to be 400 µg/l TNB, 600 µg/l TNT, and 200 µg/l RDX. These compound-specific concentrations resulted from sampling and analyses of the groundwater during the demonstration testing. The system flow rate and the influent concentrations were assumed constant during each simulation.

6.4.1.2. For each simulation, the target effluent concentration for each contaminant was set at 2.0 µg/L or less.

6.4.1.3. Certain parameters in the model were provided with preset values including: (1) ozone transfer efficiency = 90%, (2) peroxide-to-ozone ratio = 0.5, and (3) number of continuously stirred tank reactors (CSTRs) per contactor = 1. These values were assumed constant during each simulation. Although the transfer efficiency measured during project was consistently below 85%, it is believed that increasing the sidewater depth from 10 ft to greater than 18 ft would increase the ozone transfer efficiency to greater than 90%. This is based on the project team's experience with the design of ozone contactors for water treatment plants where greater than 95% ozone transfer efficiency is achieved with 20-ft side water depth.

6.4.1.4. The minimum applied ozone dosage tested during the testing program was approximately 30 mg/L, and this was used as a boundary condition for the model. This means that even though the model suggests that it may be possible to achieve effluent goals with an ozone dosage less than 30 mg/L, this condition was not simulated. Similarly, the maximum applied dosage during the demonstration testing was 115 mg/L, and this was used as another boundary condition for the model.

6.4.1.5. Simulations were conducted with 2, 3, and 4 parallel trains. In other words, the first simulation called for two trains with a flow of 500 gpm through each train. For the second simulation, the total flow was split evenly into three 333-gpm trains, and so on. A single treatment train would require too many contactors in series or such a large capacity ozonation system that it would be cost prohibitive. For this reason, no simulations were conducted for a single treatment train system. Similarly, a Peroxone system with greater than 4 treatment trains would require too many contactors and may not be practical from an operational standpoint.

6.4.1.6. Head loss is a consideration in design of treatment systems with multiple reaction tanks and gravitational flow. The head loss increases with an increase in the number of tanks per treatment train. A higher head loss in the treatment train requires either a system design in which the first reaction tank is the tallest with consecutive tanks having a smaller side wall depths so that the liquid can flow by gravitational head or increasing the inter-connecting pipe size. Changing the side wall depth means that each reaction vessel would produce a different percent removal efficiency. An extra large pipe would increase the total height of the tank and impact the system cost. To minimize the impact of head loss on the system design, the total number of tanks per treatment train was limited to eight and this criterion is based on experience gained from the demonstration system design.

6.4.1.7. Table 6-2 shows the various combinations that were simulated during the full-scale Peroxone system development process. Note that the simulations were conducted for each tank configuration described in Table 6-1.

Table 6-2
Simulated Configurations

Number of Trains	Contactors per Train	Total Number of Contactors	Applied Ozone Dose per Contactor (mg/L)
2	6	12	30 -115
2	7	14	30 - 115
2	8	16	30 - 115
3	6	18	30 - 115
3	7	21	30 - 115
3	8	24	30 - 115
4	6	24	30 - 115
4	7	28	30 - 115
4	8	32	30 - 115

6.4.2 Peroxone Model Simulation Results

6.4.2.1. Simulation results indicate that for 6-foot or 7-foot diameter tanks, none of the combinations of number of trains, number of contactors per train, and applied ozone dosage within the model boundary conditions were capable of treating influent groundwater to the desired effluent quality. Results of these simulations are thus not included for discussion. Table 6-3 shows the simulation results using an 8-foot diameter and 24-foot side wall depth contactor. Note that only the combinations capable of meeting the desired effluent quality within the model boundary conditions are shown on the table.

Table 6-3

Simulation Results: 8-Foot Dia And 24-Foot Swd Contactor

Run No.	Number of Trains	Contactors per Train	Total Number of Contactors	O_3 Dose per Contactor (mg/L)	Cumulative O_3 Demand (lb./day)
1	3	7	21	85	7,140
2	3	8	24	38	3,648
3	4	7	28	30	2,520

6.4.2.2. A typical output from the model simulations is shown on the following page. The model predicts the number of contactors required in each train to meet the effluent quality, lists the pounds per day of ozone required for each train, and estimates the total daily ozone requirement of the system. The model also predicts the effluent concentration of each contaminant from individual contactors. As an example, for the model simulation with 4 trains, seven contactors are required in each train for a total of 28 contactors and the total cumulative ozone demand of the treatment system is 2,520 pounds per day to meet the effluent quality.

6.5 EVALUATION OF PEROXONE SYSTEM MODEL SIMULATIONS

6.5.0.1. This section evaluates the results obtained from the model simulations described above. The purpose of this evaluation is to weigh the technical effectiveness of each system configuration against capital and O&M costs and operational strategy.

FULL-SCALE PEROXONE DESIGN MODEL FOR EXPLOSIVES REMOVAL

Developed by Issam Najm, Ph.D. Applied Research Department, Montgomery Watson. 1997

(INPUT BOLD CELLS)

Influent Water Quality Conditions:

Total Water Flow Rate =	**1000**	gpm
Number of Parallel Trains =	**4**	
Water Flow Rate/train =	250	gpm
TNB Influent Concentration =	**400**	μg/L
TNT Influent Concentration =	**600**	μg/L
RDX Influent Concentration =	**200**	μg/L

Contactor Configuration:

Side Water Depth, H =	**24**	ft
Contactor Diameter, W =	**8**	ft
ntactor Cross-Sectional Area, L =	50.3	sq. ft
Contact Time/Chamber =	36	min
No. of CSTRs/Chamber =	**1**	
Applied Ozone Dose/Chamber =	**30**	mg/L
Ozone Trans. Efficiency =	**90**	%
ansfered Ozone Dose/Chamber =	27	mg/L
H_2O_2 Dose/Chamber =	13.5	mg/L

Kinetic Parameters:

	TNB	TNT	RDX	
k	0.015	0.006	0.054	$(mg/L)^{-m}(min)^{-n}$
m	0.237	0.662	0.000	

Note: Model based on the following equation:

$$dC/dt = - k D^m C$$

Assumptions and Limitations:

1. MODEL USE FOR DEMONSTRATION PURPOSE ONLY.
2. Contactor height and diameter from UL Listed tank size chart.
3. Contactor dimension and contact time have been selected based on the demonstration testing and available literature.
4. Applied ozone dosage from demonstration testing.
5. Assumed 90% maximum transfer efficiency under normal conditions. (transfer efficiency may vary depending on contactor configuration)
6. Peroxide dosage based on a 0.5 Peroxone ratio.

Parameter	Unit	CONTACTOR IN EACH TRAIN											
		1	2	3	4	5	6	7	8	9	10	11	12
Cumulative Contact Time	min	36	72	108	144	180	217	253	289	325	361	397	433
Cumulative Applied Ozone Dose	mg/L	30	60	90	120	150	180	210	240	270	300	330	360
Cumulative Ozone Consumption/	lbs/day	90	180	270	360	450	540	630	720	810	900	990	1080
Total Cumulative Ozone Consum	lbs/day	360	720	1080	1440	1800	2160	2520	2880	3240	3600	3960	4320
Effluent TNB Concentration	μg/L	182	82.8	37.7	17.1	7.8	3.5	1.6	0.7	0.3	0.2	0.1	0.0
Effluent TNT Concentration	μg/L	213	75.4	26.7	9.5	3.4	1.2	0.4	0.1	0.1	0.0	0.0	0.0
Effluent RDX Concentration	μg/L	67	22.8	7.7	2.6	0.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0

6.5.1. Technical Evaluation

6.5.1.1. For evaluation of technical feasibility, only the three combinations shown in Table 6-3 are considered. Each configuration is capable of meeting the effluent quality goals and is thus technically effective. However, the ozone demand for Run No. 1 (three trains and seven contactors per train) is significantly higher compared to Run No. 2 and No. 3. This higher ozone demand would necessitate a much larger and a very different type of ozonation which is generally not used for hazardous waste treatment facilities. For this reason, Run No. 1 is deleted from further discussions.

6.5.2. Cost Evaluation

6.5.2.1. Table 6-4 presents the capital cost, annual O&M costs, and the 20-year present worth cost for the two configurations under consideration.

Table 6-4
Preliminary Cost Estimates

Run No.	Number of Trains	Contactors per Train	System Capital Cost	System Annual O&M Cost	System 20-Year Present Worth
2	3	8	$14,160,000	$1,113,000	$26,924,000
3	4	7	$13,447,000	$906,000	$23,837,000

6.5.2.2. The cost estimates are for a complete groundwater extraction, conveyance, and treatment facility including extraction wells, groundwater conveyance piping network, influent storage, treatment facilities, effluent storage and discharge, ozonation systems, and a chemical feed system. Cost for the treatment system also include a structural pad, a metal building, electrical and instrumentation, and civil and mechanical work.

6.5.2.3. The costs are based on parametric cost estimates with a +50% to -30% accuracy. Cost data were obtained from equipment vendors, Means Building Construction Cost Data 1995, the Environmental Restoration Unit Cost Book, and other available sources.

Some of the constraints related to the full-scale system costs are included on Table 6-6 as footnotes.

6.5.2.4. As shown on Table 6-4, both the capital and O&M costs are reduced with an increase in the number of trains. The primary reduction in the full-scale system capital cost results from reduced ozone demand and hence a smaller ozone generation system which is the primary cost for the Peroxone system.

6.5.2.5. The full-scale system O&M costs are primarily dependent on the total ozone demand of the system with minor contributions from hydrogen peroxide demand, system labor requirements, and other operational activities. Since the total ozone demand of the system decreases with increasing number of trains, the annual O&M costs for the full-scale system is reduced as the number of trains is increased.

6.5.2.6. Present worth costs were calculated over a 20-year project duration using an 6 percent annual compound interest rate.

6.6 FULL-SCALE PEROXONE SYSTEM

6.6.0.1. Selection of a full-scale system would require detailed evaluation of site conditions, influent concentrations, contactor design options, and other considerations described earlier in this section. Based solely on the model simulations and evaluation results presented in this section, a system with 4 parallel trains (i.e., flow evenly split into 4 trains) should provide the most technically feasible and cost-effective system for treatment of explosives-contaminated groundwater at the CAAP. The selected configuration also provides other benefits that are discussed below. However, it should be emphasized that the proposed design criteria is only one of many viable alternatives. A more detailed and comprehensive cost analysis is required in order to fully optimize the design of the treatment plant.

6.6.0.2. Splitting the flow evenly into 4 parallel trains provides flexibility in the system operation. An individual treatment train can be removed from operation without adversely affecting the entire treatment process. With 4 trains, removal of an individual train reduces the total treatment capacity by only 250 gpm.

6.6.0.3. A treatment process with multiple trains provides flexibility to construct the system in phases. A multi-phase construction program would eliminate the need for a large capital investment up front and still satisfy regulatory requirements for a treatment system. Treatment trains can be added later as desired.

6.6.0.4. A multi-train treatment process also offers the benefit of reducing the treatment capacity in phases toward the end. Early removal of unneeded capacity will result in O&M cost savings without affecting the treatment process.

6.6.1. Full-Scale Peroxone System Design Criteria

6.6.1.1. Preliminary design criteria for a hypothetical extraction and treatment system are included on Table 6-5. The design criteria for the Peroxone treatment process are based on the flow requirements and treatment goals stated in the SOW. The design criteria for the groundwater extraction and conveyance system is hypothetical and will depend on site conditions, site geology and hydrogeology, as well as state and local codes and guidelines. It is noted that a LOX system was assumed as an oxygen source for ozone generator. Preliminary cost estiamtes have shown that the total annual cost of a PSA or VSA system is comparable to, if not slightly higher than, a LOX feed system.

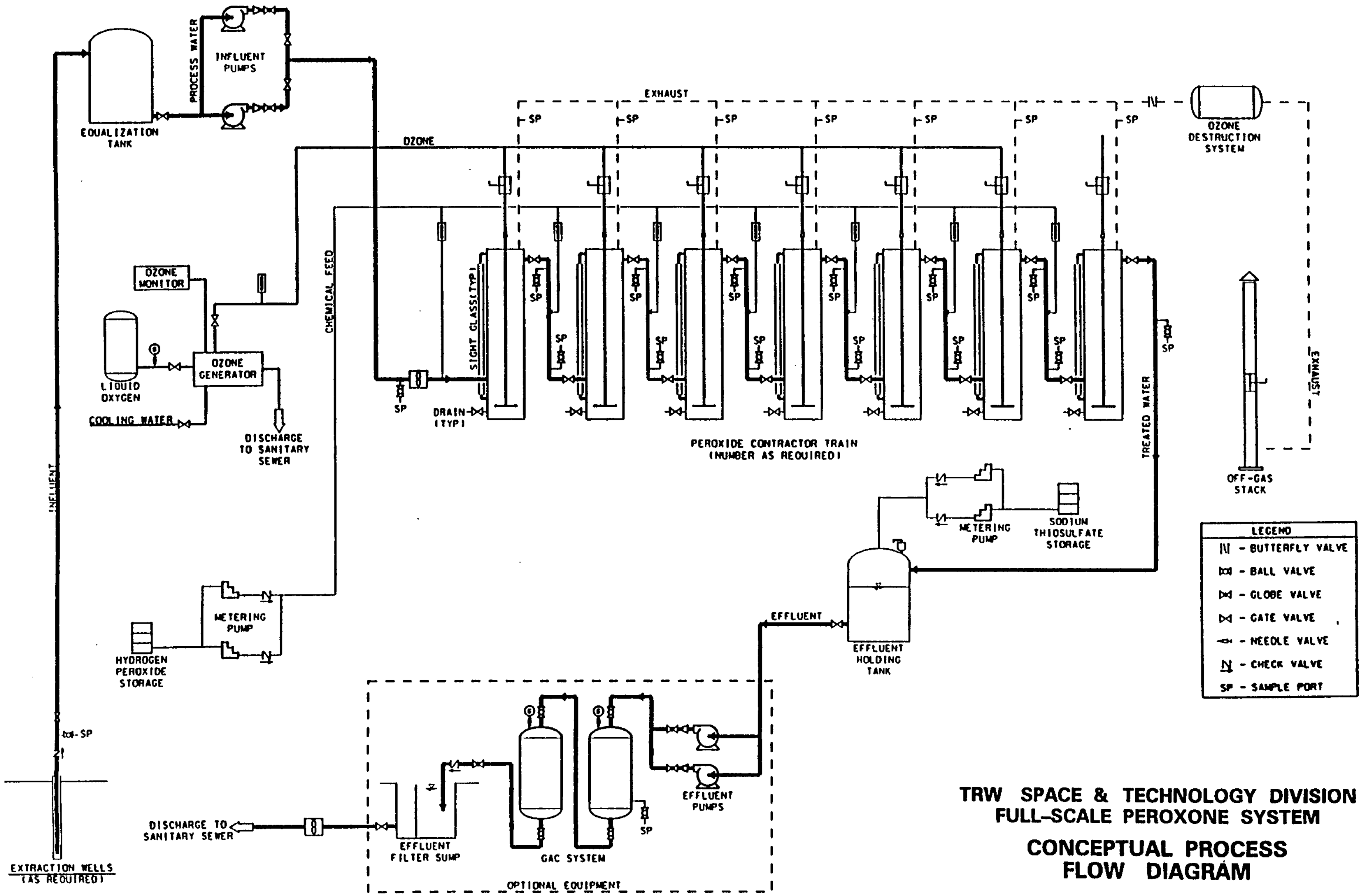
6.6.1.2. Table 6-5 is not intended as an exhaustive inventory of materials, but summarizes major components of the full-scale treatment system.

6.6.1.3. Figure 6-1 presents a conceptual Process Flow Diagram (PFD) for the recommended full-scale Peroxone system. Note that several other supporting equipment and components would be required for a full-scale Peroxone treatment system which are not shown on the PFD.

6.6.2. Full-Scale Peroxone System Cost Estimates

6.6.2.1. A detailed preliminary capital and O&M cost estimate for the recommended full-scale Peroxone system is presented in Table 6-6. These costs estimates are not intended for use as a construction estimate.

Full-Scale Peroxone System Conceptual PFD



TRW SPACE & TECHNOLOGY DIVISION
FULL-SCALE PEROXONE SYSTEM

CONCEPTUAL PROCESS FLOW DIAGRAM

FIGURE 6-1

Table 6-5

Full-Scale Peroxone System Conceptual Design Criteria

Equipment	Description	Criteria	Comments
Extraction Well	Number of wells Well casing	40 6-inch (min)	Number of wells varies based on the site hydrogeology and groundwater yield rates.
Well Head	Number Pipe Type Vault Type	40 (one for each well) Heat traced carbon steel pipe Concrete, flush with surface	Number of wellhead equals number of wells installed. Each well provided with magnetic meter to control flow rate.
Extraction Pump	Number Type Capacity	40 (one for each well) Submersible, electrical 25 gpm each	Pump number and capacity depends on the site conditions. Total head and horsepower will vary depending on well locations.
Conveyance Line	Type Location	HDPE, double contained Buried 3 feet (min) below ground surface	Provide freeze protection and leak detection system. Pipe size will depend on flow from individual wells and piping layout.
Influent Flow Meter	Range Number Type	100-1000 gpm 1 Magnetic	Indication of total flow to the treatment system. Assumed that 10% of the wells will be in the discharge mode at a given time.

Table 6-5

Full-Scale Peroxone System Conceptual Design Criteria (Continued)

Equipment	Description	Criteria	Comments
Equalization Tank	Number	2	Two 10,000 gal tanks provide flexibility in system operation while minimizing down time.
	Capacity	10,000 gallon each	
	Tank Material	High density polyethylene	HDPE suitable material for long-term protection.
Influent Pump	Number	5 (four plus one standby)	One pump for each train allows flexibility in system operation with one standby to minimize system operation down time.
	Type	Centrifugal, end suction	
	Capacity	250 gpm each	
Ozone Contactor	Number of contactors	28 (7 per train)	36 minute retention time per contactor. 316 SS for long-term protection against ozone corrosion. Provide manway at the top and bottom side.
	Type	Unpacked column	
	Capacity	10,000 gal (each appr.)	
	Size	8 feet diameter, 24 feet high	
	Material	316 SS	
Effluent Storage Tank	Capacity	10,000 gal	10 minute retention time at 1,000 gpm flow for thiosulfate mixing.
	Number	1	
	Type	High density polyethylene	
Effluent Pump	Number of pumps	3 (two plus one standby)	Two pumps allow flexibility in system operation while minimizing down time.
	Type	Centrifugal, end-suction	
	Capacity	500 gpm (each)	

Table 6-5

Full-Scale Peroxone System Conceptual Design Criteria (Continued)

Equipment	Description	Criteria	Comments
Effluent Flow Meter	Range Type Number	10-1000 gpm Magnetic 1	Indication of total discharge from the treatment system. Other NDEQ limitations may apply for discharge monitoring.
Ozone Generator	Capacity Ozone Dosage (each vessel)	2,520 lb/day 30 mg/l at 10% ozone by weight	See "Full-Scale Peroxone Model" for calculations details.
Hydrogen Peroxide System	Daily Capacity Applied dosage	1,135 lb/day of 35% solution 15.0 mg/l (each contactor)	
Sodium Thiosulfate System	Daily Capacity Applied dosage	84 lb/day of pure solution 7 mg/L per mg/L of residual ozone	

Table 6-6

Preliminary Cost Estimate for 1,000 gpm Peroxone System[(1)]

Item/Description	Quantity	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
General				
Contractor Mobilization[(2)]		lump sum	$100,000	$100,000
Contractor Demobilization[(2)]		lump sum	$50,000	$50,000
Treatment System Pad[(3)]	556	cubic yard	$230	$127,778
Excavated Soil Disposal[(4)]	9,228	ton	$50	$461,421
			Subtotal	*$739,199*
Groundwater Extraction System				
Vertical Extraction Wells[(5)]	40	each	$15,000	$600,000
Conveyance Pipe[(6)]	50,000	linear foot	$35	$1,750,000
			Subtotal	*$2,350,000*
Groundwater Treatment System				
Equalization Tanks	2	each	$12,000	$24,000
Influent Transfer Pumps	5	each	$12,500	$62,500
Automatic Pressure Filters	4	each	$12,500	$50,000
SS 316 Contactors[(7)]	28	each	$35,000	$980,000
Ozonation System[(8)]		lump sum	$2,000,000	$2,000,000
Chemical Feed System[(9)]		lump sum	$50,000	$50,000
Effluent Holding Tank	1	each	$12,000	$12,000
Effluent Transfer Pumps	3	each	$15,000	$45,000
Polishing GAC Vessels (optional equipment - see footnote 10)				
			Subtotal	*$3,223,500*
			Total Direct Capital Costs (DCC)	$6,313,000
INDIRECT CAPITAL COSTS[(11)]				
Equipment Installation (10% of DCC)		lump sum		$631,300
Mechanical Piping/Accessories (10% of DCC)		lump sum		$631,300
Electrical and Instrumentation (18% of DCC)		lump sum		$1,136,340
Civil/Site Improvements (10% of DCC)		lump sum		$631,300
Building/Facilities (6% of DCC)		lump sum		$378,780
Design/Engineering (15% of DCC)		lump sum		$946,950
Permitting and Approvals (2% of DCC)		lump sum		$126,260
Construction Management (8% of DCC)		lump sum		$505,040
Contractor's Fee (4% of DCC)		lump sum		$252,520
Contingency (30% of DCC)		lump sum		$1,893,900
			Total Indirect Capital Costs	$7,133,690
			TOTAL CAPITAL COSTS[(16)]	**$13,447,000**

Table 6-6
Preliminary Cost Estimate for 1,000 gpm Peroxone System
(Continued)

Item/Description	Quantity	Unit	Unit Cost	Annual Cost
OPERATION AND MAINTENANCE COSTS				
Ozonation System(12)	12	per month	$38,430	$461,160
Chemical Additives	12	per month	$15,000	$180,000
Electrical Power(13)	150	kw-hr	$0.08	$105,120
Labor(14)	2,920	per hour	$30	$87,600
Analytical Cost(15)	12	per month	$5,000	$60,000
General Maintenance	12	per month	$1,000	$12,000
			ANNUAL O&M COSTS(16)	**$906,000**
PRESENT WORTH				
Interest Rate = 6%	Project Life = 20 Years			
			20-YEAR PRESENT WORTH(16)	$23,837,000

1 Parametric cost estimate based on standard engineering practice and costing methods. Refer to Section 6.0 of the Report for items not included in the cost estimate. Accuracy of cost estimate is within the +50% to -30% range.
2 Single mobilization and demobilization assumed for the treatment system construction.
3 A 200-foot x 100-foot x 1-foot thick concrete slab on footings with a 1-foot containment berm.
4 50 percent of excavated soil disposed at a Subtitle D (non-hazardous) landfill.
5 A 6-inch diameter well, average vertical depth 30 feet bgs, 15-foot SS screen. Cost includes drilling, installation, well-head completion, development, pump electrical, and controls. Number of wells will vary depending on site hydrogeology and groundwater yield rates.
6 Assumes 2-inch double-contained HDPE pipe. Total pipe length will vary depending on well locations, pipe routing and layout, and the treatment system siting.
7 Each contactor 8 feet in diameter and 24 feet tall; SS 316 shell material with a top and bottom manway; no packing included.
8 Vendor quote (Ozonia, Lodi, NJ) for a complete system including liquid oxygen storage and feed, ozone generators, nitrogen generator and feed system, demisters, preheaters, residual ozone destruct units, vent gas blowers, and power supply and control systems.
9 Complete chemical feed system including chemical storage, day tanks, chemical feed pumps and piping, and control systems.
GAC vessels may be required by NDEQ. Cost not included in the estimate.
Parametric cost estimate based on standard engineering practice and costing methods.
Vendor quote (Ozonia, Lodi, NJ) based on per pound of ozone generated, excluding labor and chemical additives.
Excluding cost for the ozonation system which is included in item 12 above.
One operator, 8 hours per day, 7 days a week at $30 per hour.
Analysis for pH, oil & grease, explosives, general minerals, and other parameters.
Cost values rounded to the nearest $1,000.

7.0 SUMMARY, CONCLUSIONS, & RECOMMENDATIONS

7.1 INTRODUCTION & SYSTEM DESIGN

7.1.1. This project was aimed at demonstrating the applicability of the Peroxone process (i.e., Ozone with Hydrogen Peroxide) for the remediation of explosives-contaminated groundwater at the Cornhusker Army Ammunition Plant (CAAP) in Grand Island, Nebraska. The primary contaminants were TNT, TNB, and RDX. The measured concentration of each of these contaminants in the groundwater varied from 114 μg/L to 1200 μg/L for TNT, 114 mg/L to 711 μg/L for TNB, and 0.01 μg/L to 74 μg/L for RDX. The treated water concentration goal for each contaminant was set at 2 μg/L.

7.1.2. The Peroxone demonstration plant design criteria, developed by the project Technical Advisory Board, was based on bench-scale and pilot-scale testing conducted by the US Army Corps of Engineers (USACE) at the Waterways Environmental Station (WES). The plant consisted of three main parts. The first part was a groundwater extraction system drawing water from two wells at CAAP. The second part was the main Peroxone treatment process which consisted of six (6) 12-foot high stainless-steel contactors operated in series (the sidewater depth in each contactor was approximately 10 ft). Hydrogen peroxide was added to the influent stream to each contactor while an ozone-rich gas stream was bubbled through each contactor via two stone diffusers installed at the bottom of each contactor. The third part was a Granular Activated Carbon (GAC) treatment process intended to capture any contaminants present in the effluent of the Peroxone treatment process prior to discharging the water into a nearby ditch. The GAC treatment process consisted of three GAC vessels operated in series.

7.1.3. The Peroxone treatment process was designed to treat a maximum groundwater flow rate of 25 gpm at a maximum applied ozone dose of 55 mg/L in each of the six contactors. This results in a maximum total applied ozone dose of 330 mg/L. At the design flow rate of 25 gpm, the average hydraulic residence time (HRT) in each contactor was 24 minutes for a total HRT of 144 minutes. The hydrogen peroxide feed system was designed to provide sufficient hydrogen peroxide to result in a Peroxone weight ratio of 0.3 mg/mg. The Peroxone weight ratio is the ratio of applied hydrogen peroxide dose (expressed in mg/L) to the transferred ozone dose (expressed in mg/L).

7.2. SYSTEM TESTING PLAN

7.2.1. The treatment train was operated for a total of 14 weeks. During the first two weeks, debugging of the treatment processes and equipment was conducted. During the next four weeks, an optimization task was conducted during which the Peroxone process performance for contaminants destruction was evaluated under varying conditions of ozone dose, contact time, and water source. During the final eight (8) weeks of the testing schedule, a demonstration task was conducted during which the system was operated under two sets of conditions for a period of 4 weeks each.

7.2.2. During the first phase of the demonstration task, the system was operated at an average flow rate of 13 gpm (which corresponded to an average HRT of 46 minutes in each contactor), an average transferred ozone dose of 78 mg/L, and an average Peroxone ratio of 0.45 mg/mg. During the second phase of the demonstration task, the system was operated at an average flow rate of 25 gpm (which corresponded to an average HRT of 24 minutes in each contactor), an average transferred ozone dose of 44 mg/L, and an average Peroxone ratio of 0.57 mg/mg.

7.2.3. The performance of the treatment process was monitored on a daily basis. Water samples were collected from the effluent of each of the six contactors, as well as from the effluent of the GAC process, and transported to GP Laboratories in Gaithersburg, MD.

7.3. SYSTEM PERFORMANCE

7.3.1. The experimental results obtained showed that TNB was the most difficult compound to remove with the Peroxone process, followed by RDX, and finally by TNT which was the most readily removed compound. However, the results of the project showed that the Peroxone system was not capable of achieving the target explosives' removals at the design dose of 330 mg/L and a total contact time of 144 minutes (2.4 hours). In order to achieve the target water quality goals, the contact time was increased to 276 minutes (4.6 hours) by reducing the groundwater flow rate into the system from 25 gpm to 13 gpm, and the applied ozone dose was increased to 600 mg/L. With an ozone transfer efficiency of approximately 78 percent, the transferred ozone dose was approximately 470 mg/L.

7.3.2. This project also demonstrated that the Peroxone ratio had to be increased from the design value of 0.3 mg/mg to approximately 0.5 mg/mg in order to maintain a low ozone residual in the effluent water and a high ozone transfer efficiency. Therefore, at the transferred ozone dose of 470 mg/L and a Peroxone ratio of 0.5 mg/mg, the required hydrogen peroxide dose was 235 mg/L divided equally among the six contactors.

7.3.3. While a high transferred ozone dose of 470 mg/L and a long contact time of 4.6 hours were required to meet the effluent water quality goal of 2 µg/L for each individual contaminant, a lower transferred ozone dose of 265 mg/L and a shorter contact time of 2.4 hours removed TNB to an effluent concentration of 2 to 4 µg/L, while achieving complete removals of TNT and RDX. Since the cost of the Peroxone process is highly impacted by the required ozone dose, this finding suggests that a hybrid treatment system of a Peroxone process for partial explosives removal, followed by a polishing treatment process (such as GAC adsorption) for removing the remaining explosives, may be far more cost effective than a stand-alone Peroxone process designed for complete explosives removal. However, it is noted that this approach does not address the possible formation of oxidation by-products which may consume the GAC capacity more rapidly.

7.4. MODEL DEVELOPMENT

7.4.1. In order to develop the design criteria for a 1000-gpm Peroxone treatment process, Montgomery Watson developed an empirical model to simulate the removal of TNT, TNB, and RDX by the Peroxone process. The model contained two empirical coefficients which were estimated by fitting the model calculated removals to those measured through each contactor. The model was successful in simulating the optimization task results and those of the first phase of the demonstration task. However, it somewhat underestimated the removals of TNT, TNB, and RDX measured during the second phase of the demonstration task.

7.4.2. It is emphasized that the mathematical model developed in this project is purely empirical, and is limited to the ranges of concentrations, doses, and contact times evaluated in this project. In addition, its accuracy is highly dependent on the hydraulics of the contactor, as well as the quality of the source water. Therefore, the model should be used with caution when estimating the removals of TNT, TNB, and RDX with the Peroxone process.

7.5. DESIGN & COST OF FULL-SCALE SYSTEM

7.5.1. Based on the results of the testing program, the empirical model was used to develop a preliminary design criteria and cost of a 1000-gpm Peroxone treatment system for removing TNT, TNB, and RDX from CAAP groundwater. There are several design configurations that are applicable for this plant. One of the configurations was selected for this plant, and is listed in Table 7-1. It should be noted that the design criteria is highly dependent on the influent concentrations of TNT, TNB, and RDX. For the purposes of this design, the groundwater concentrations of TNT, TNB, and RDX were assumed at 600 μg/L, 400 μg/L, and 200 μg/L, respectively. The target effluent concentration of each contaminant was set at 2 μg/L.

Table 7-1

Conceptual Design Criteria of 1000-gpm Peroxone Treatment Plant

Parameter	Unit	Value
Total Water Flow Rate	gpm	1,000
Number of Parallel Trains	—	4
Flow Rate per Train	gpm	250
Number of Contactors per Train	—	7
Total Number of Contactors	—	28
Contactor Type	stainless-steel cylindrical columns	
Contactor Diameter	ft	8
Side-water Depth	ft	24
Contact Time per Contactor	min	36
Total Contact Time	min	252
Ozone Dose per Contactor	mg/L	30
Total Ozone Dose per train	mg/L	210
Ozone Capacity	lbs/day	2,520
Ozone Transfer Efficiency*	%	90
Peroxone Ratio	mg/mg	0.5
Total Hydrogen Peroxide Dose	mg/L	95
Hydrogen Peroxide Capacity	lbs/day	1,135

* The ozone transfer efficiency of 90% was assumed based on the project team's experience with the design of ozone contactors with such side water depth.

7.5.2. The plant consists of four (4) parallel trains, each with a capacity of 250 gpm. Each train included seven (7) stainless-steel cylindrical contactors in series. Each contactor had a diameter of 8 ft and a side-water depth of 24 ft. At a flow rate of 250 gpm per train, the estimated contact time through each contactor is estimated at 36 minutes, for a total contact time of 252 minutes. The applied ozone dose to each contactor was estimated at 30 mg/L for a total of 210 mg/L of water treated, which translates into a required ozone generation capacity of 2,520 lbs/day. An ozone transfer efficiency of 90% was assumed. With a Peroxone ratio of 0.5 mg/mg, the required hydrogen peroxide dose was thus estimated at 95 mg/L, which translates into a total required hydrogen peroxide consumption of 1,135 lbs/day.

7.5.3. Based on the above design criteria, a preliminary capital and O&M cost estimates were developed for the 1000-gpm Peroxone treatment system. The cost breakdown is summarized in Table 7-2. The total system capital cost is estimated at $13,447,000 and the annual Operations & Maintenance costs are estimated at $906,000/yr. Assuming an amortization period of 20 years and a 6% cost of money, the total annual cost is estimated at $2,079,000/yr. The 20-yr present worth of the system is estimated at $23,837,000.

Table 7-2
Preliminary Cost Breakdown
for the 1,000-gpm Peroxone System

ITEM/DESCRIPTION	COST
Direct Capital Cost	
General	$739,200
Groundwater Extraction System	$2,350,000
Treatment System	$3,223,500
Total Direct Capital Costs (DCC)	$6,313,000
Indirect Capital Costs	$7,133,690
Total Capital Costs	**$13,447,000**
Amortized Capital Costs (8%; 30 yrs)	$1,195,000
Annual O&M Costs	**$906,000**
Total Annual Cost	**$2,079,000**
Total Cost of water	**$3.95/1000 gal**
20-year Present Worth	**$23,837,000**

7.5.4. It should be noted that the capital cost includes $600,000 for the construction of a total of 40 wells, and $1,750,000 for conveyance piping. These wells are required because the maximum individual well capacity was estimated at 25 gpm. If hydrogeological studies at CAAP determine that wells can deliver significantly higher flow rates, significant savings can be realized by reducing the number of wells and length of piping required. In addition, due to the preliminary nature of the cost estimate, the indirect capital cost estimate includes approximately $1,900,000 in capital cost contingency.

7.6. CONCLUSIONS

7.6.1. While this project demonstrated that TNT, TNB, and RDX can be reliably removed from groundwater using the Peroxone process, the amount of ozone and hydrogen peroxide needed, as well as the required contact time, are higher than initially anticipated. At CAAP, the required transferred ozone dose was estimated at 470 mg/L, with a required hydrogen peroxide dose of 235 mg/L and a contact time of 4.6 hours. These are high values when compared to ozone doses and contact times required for conventional groundwater remediation of typical organic contaminants. Due to these high chemical doses and high contact time, the total annual cost of a Peroxone treatment system designed to treat 1000 gpm of CAAP groundwater was estimated at $2,079,000/year.

7.6.2. However, this project also demonstrated that substantially lower chemical doses and lower contact time can achieve near complete removals of TNB, which was the most difficult contaminant to remove. This suggests that a hybrid treatment system of a Peroxone process for partial explosives removal, followed by a polishing treatment process (such as GAC adsorption) for removing the remaining explosives, may be far more cost effective than a stand-alone Peroxone process designed for complete explosives removal. However, it is noted that this approach does not address the possible formation of oxidation by-products which may consume the GAC capacity more rapidly than anticipated. Therefore, the concept of the hybrid system should first be tested before a conclusion can be made about the cost effectiveness of such a system.

7.7. RECOMMENDATIONS

7.7.1. The following is a list of recommendations developed as a result of the outcome of this project. The objective of these recommendations is to possibly further minimize the overall system cost.

7.7.2. Applicability of a Hybrid System Design. It is recommended that a desktop study be conducted to evaluate the hybrid process design alternative discussed above, develop the optimum design criteria for each of the two processes (i.e., Peroxone and GAC), and verify whether this hybrid system will result in a minimum total system cost. Using the empirical Peroxone process model developed in this project and various GAC adsorption models presented in the literature, system design optimization should be feasible. If such models are not available, simple laboratory studies can be conducted using CAAP groundwater samples to evaluate the adsorption of TNT, TNB, and RDX onto various types of GAC. It was noted that an identical recommendation was included in the WES report in order to help meet the desired system performance criteria while minimizing the overall system cost.

7.7.3. Evaluation of Alternative Peroxone Design Criteria. As indicated earlier, the design parameters for the Peroxone system used in this project were set by USAEC. There are various other modes of ozone application during water treatment. Considering that the performance of an ozonation process is highly dependent on the mode of ozone application and contactor hydraulics, it is recommended that a study be conducted to evaluate various Peroxone system design criteria and come up with the most cost effective design.

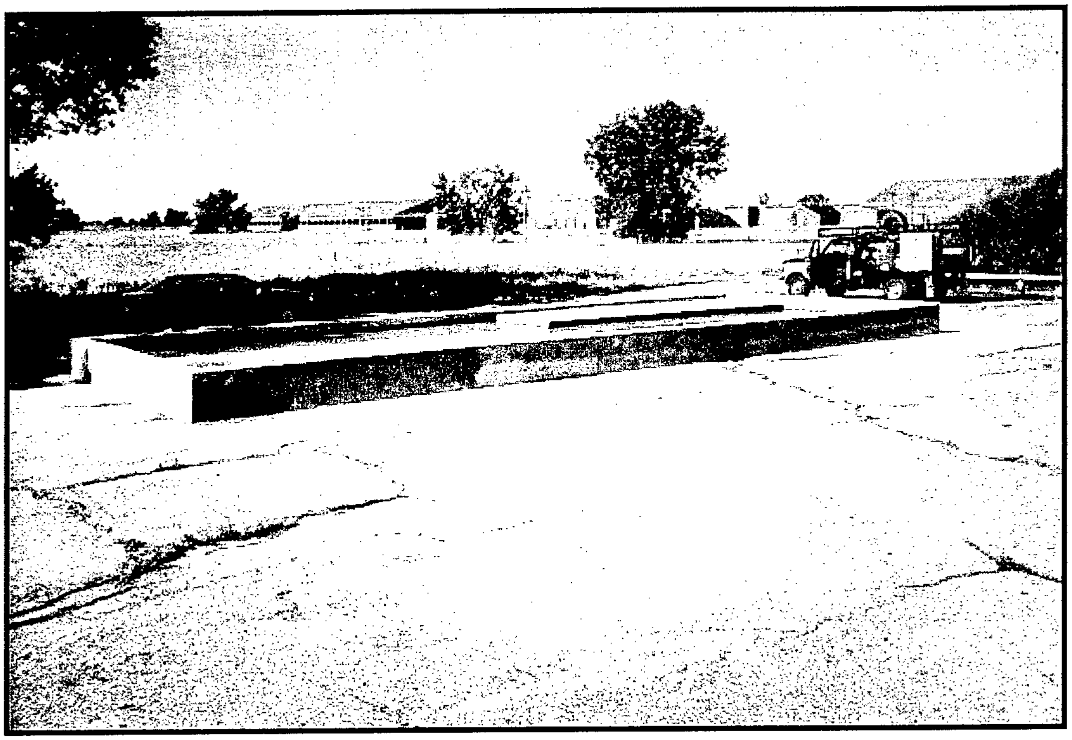
7.7.4 Confirmation of CAAP Site Results. The performance of the Peroxone process is dependent on the water quality of the groundwater being treated. This project was conducted at a single site, and evaluated the remediation of explosives from one groundwater source. The chemical dose requirements and reaction kinetics are known to be function of the background organic matrix of the water being treated. Therefore, before the results of this study are extrapolated to other sites, it is recommended that the performance of the Peroxone process be tested at other sites using other groundwater sources to confirm whether or not such high chemical doses and contact times are also required for the treatment of other waters.

7.7.5 Challenging the 2 μg/L Discharge Limit. The basis for the minimum concentration requirement of 2 μg/L for each of TNT, TNB, and RDX set in the RFP is not known, and may not be based on scientific information regarding the health effects of these contaminants. It is noted that the chemical doses and contact time (i.e., system size) required to achieve an effluent TNB concentration of 4 μg/L were virtually half those required to meet the 2 μg/L limit. Therefore, it is our recommendation that this limit be challenged by conducting a wide review of all available information on the health effects of TNB in water. If the TNB discharge limit can be raised to 5 to 10 μg/L, the cost of the treatment process may be substantially reduced by as much as 50 percent.

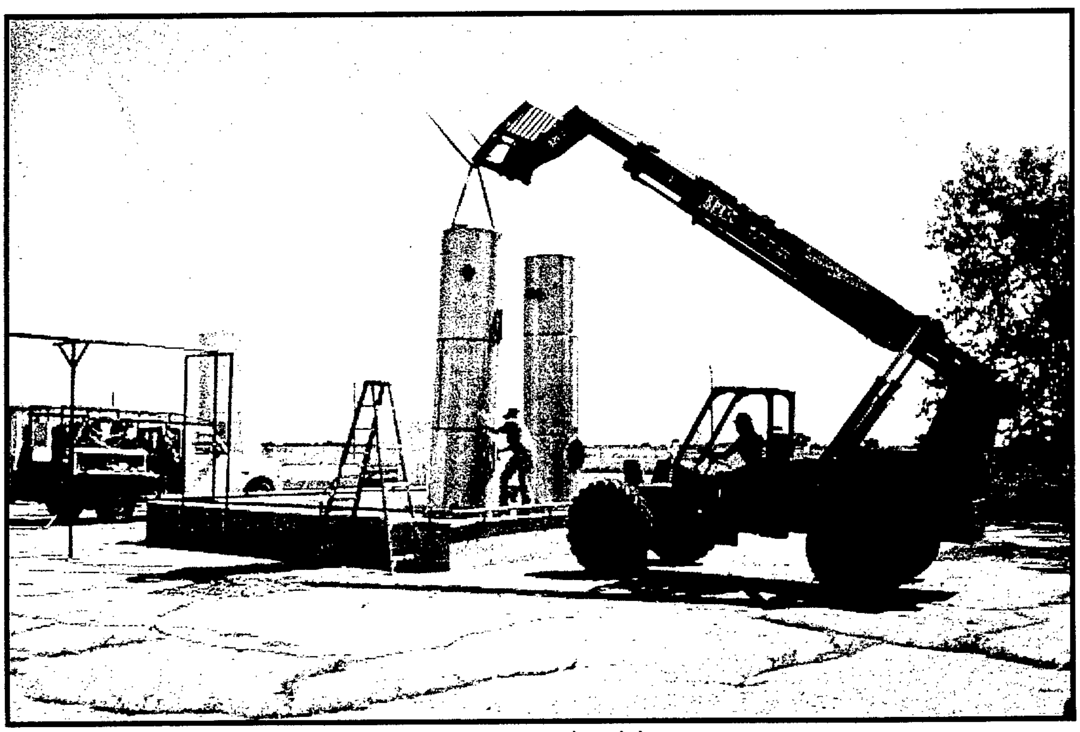
7.7.6 Conducting a more detailed cost estimate. The cost estimate developed in this report is a budgetary estimate. A more comprehensive engineering estimate should be developed in order to get a more accurate estimate of the treatment plant cost.

Appendix A

Peroxone System Construction Photographs



18 Foot x 48 foot secondary containment slab ready for Peroxone system.



Setting the first two stainless steel contactors on the slab.

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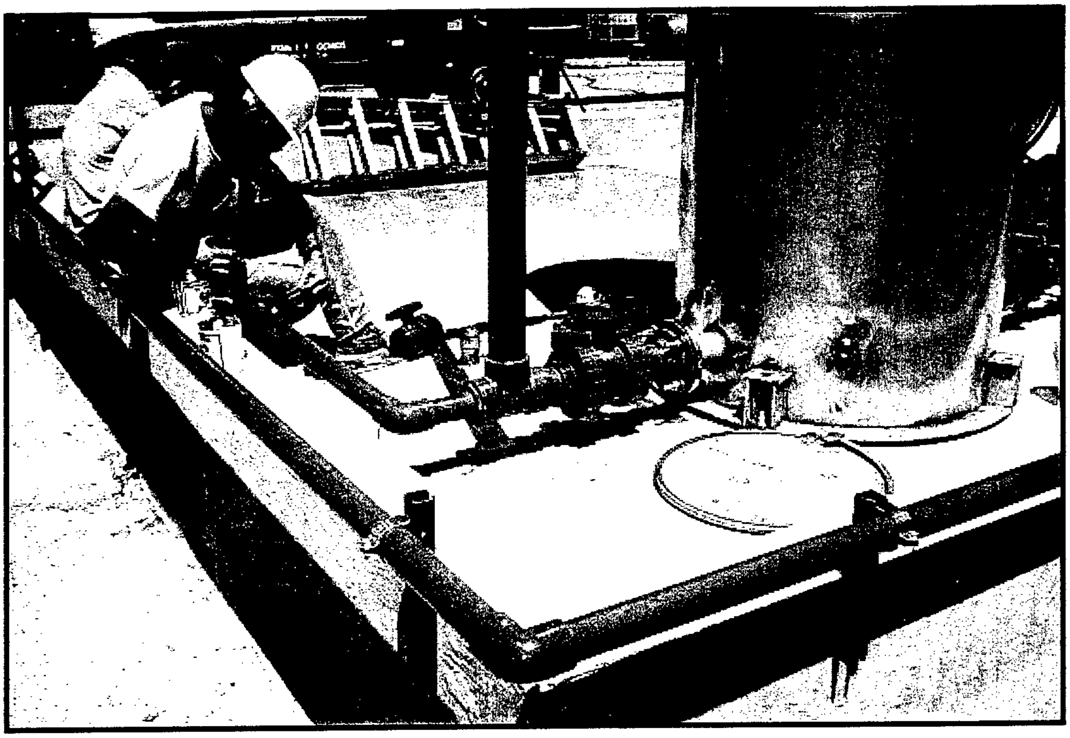
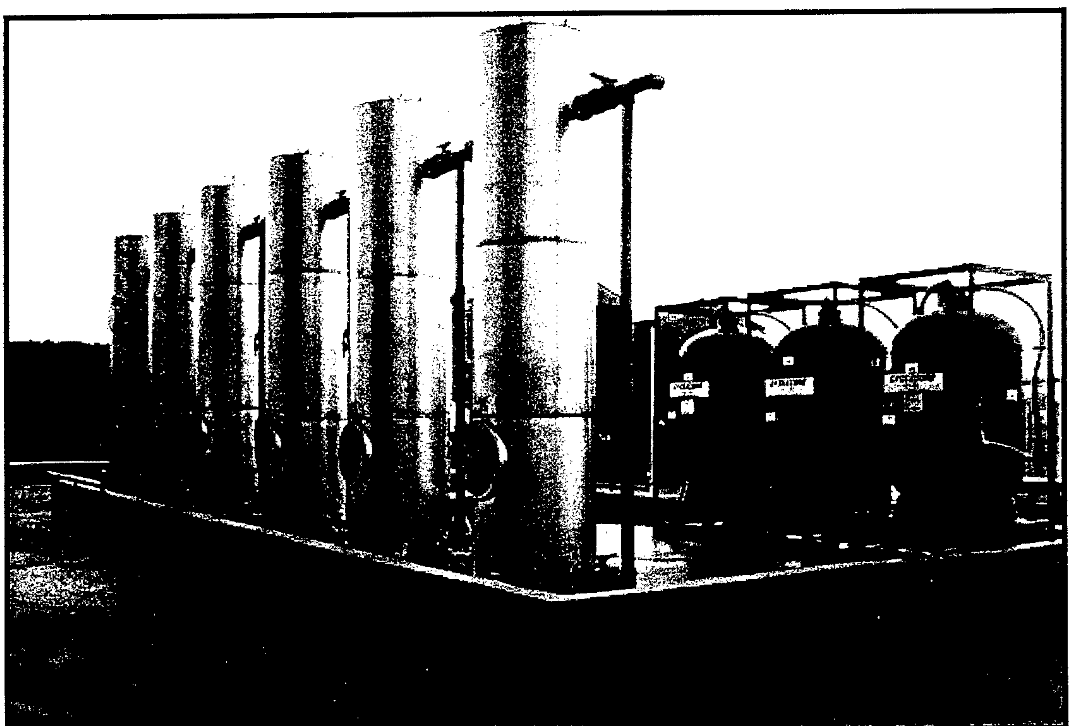
GRAND ISLAND, NEBRASKA
PHOTOS 1 & 2



Workers connecting distribution piping from extraction wells into contactor number 1.



All contactors set and 3" connection piping completed. 3 Carbon vessels delivered and set on pad (right).

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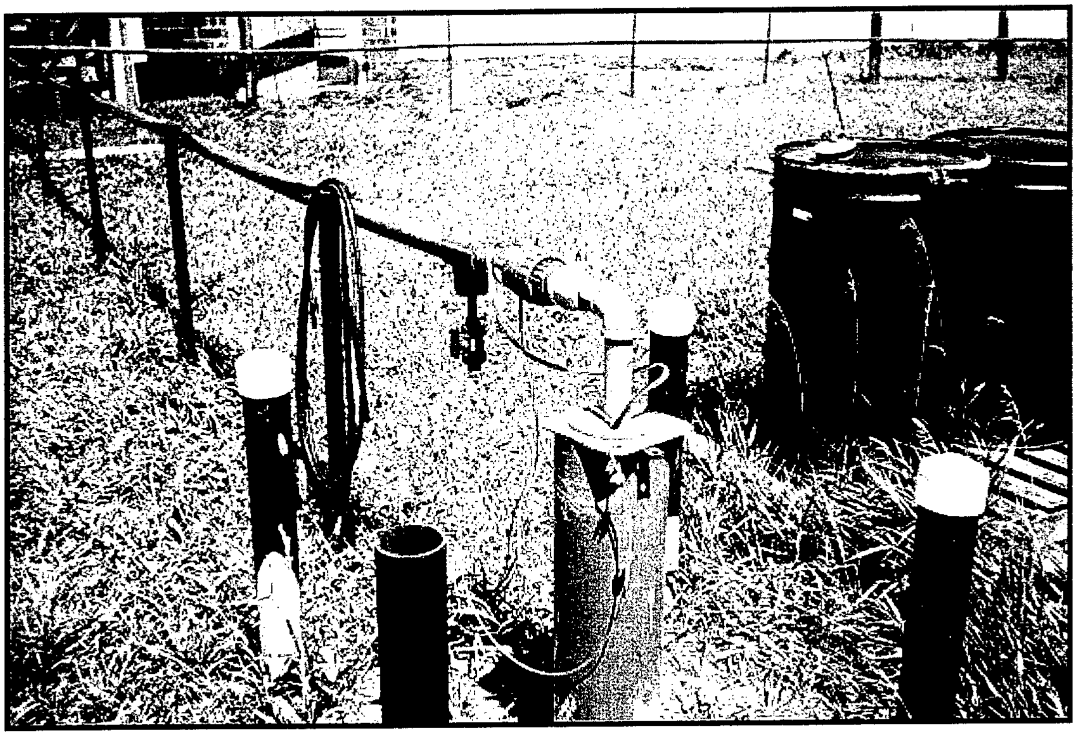
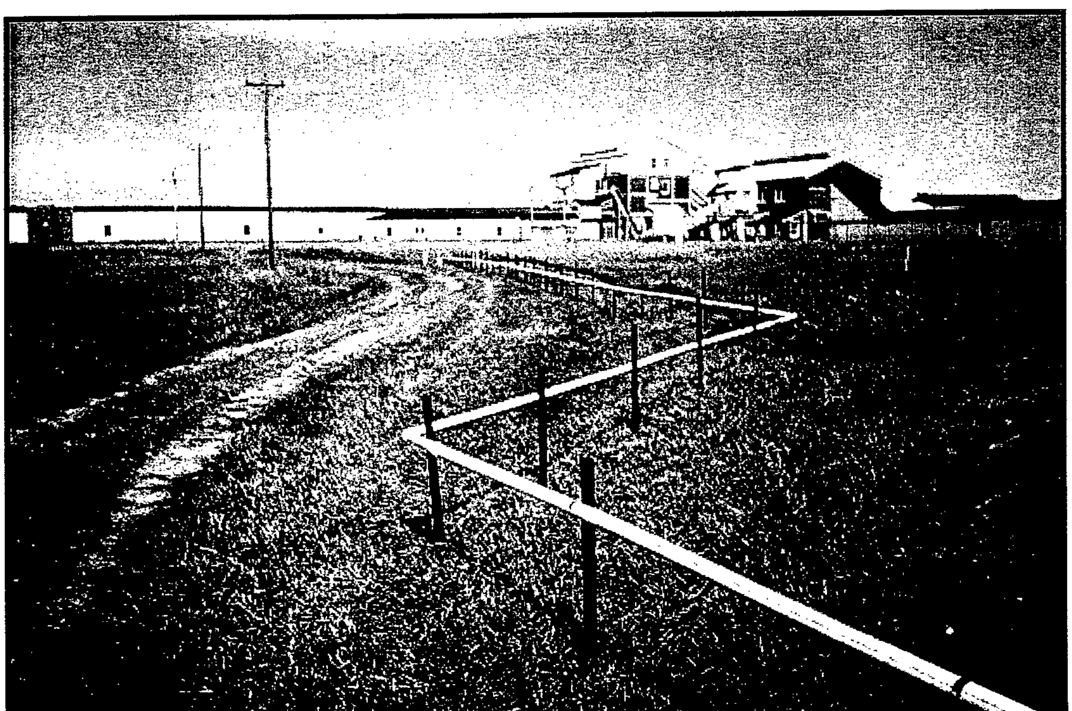
PHOTOS 3 & 4

PROJECT NO. 1166031.01091017 1/6/97



Completed wellhead for new TRW well showing 2" conveyance piping and sample port.



Water distribution system from fire hydrant (yellow object) to treatment system pad.

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CORNHUSKER ARMY AMMUNITION PLANT
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PHOTOS 5 & 6

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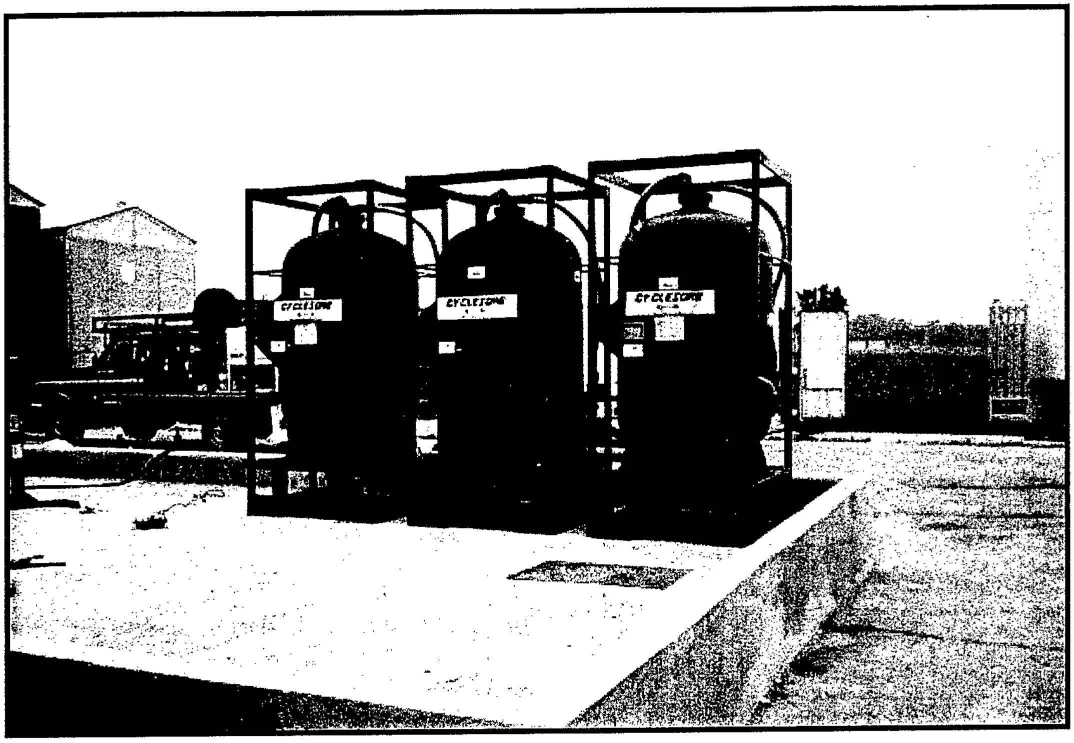
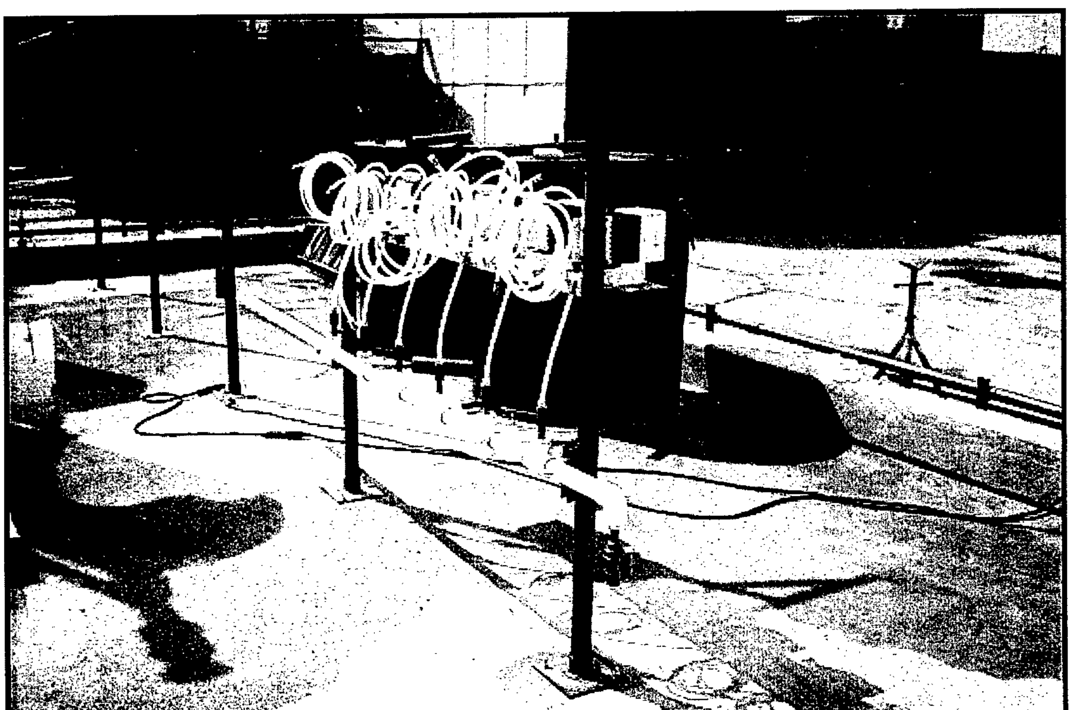


Three 1,000 pound Carbon vessels rented from Calgon Corporation.



Six hydrogen peroxide chemical feed pumps, one for each contactor vessel.

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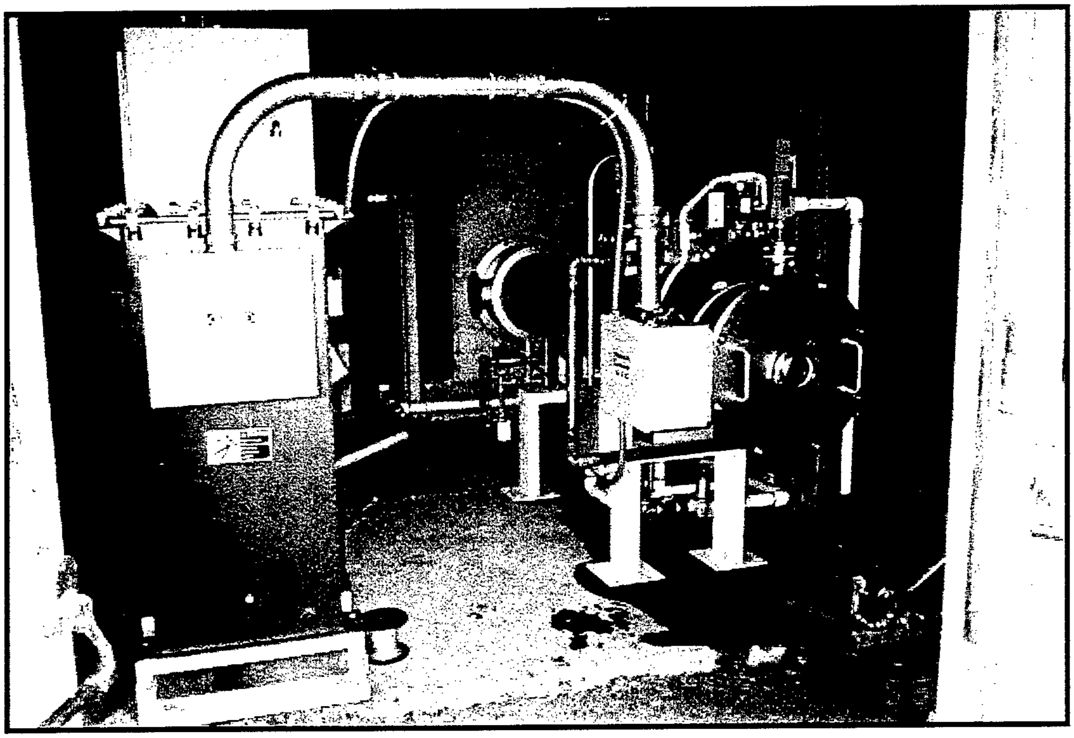
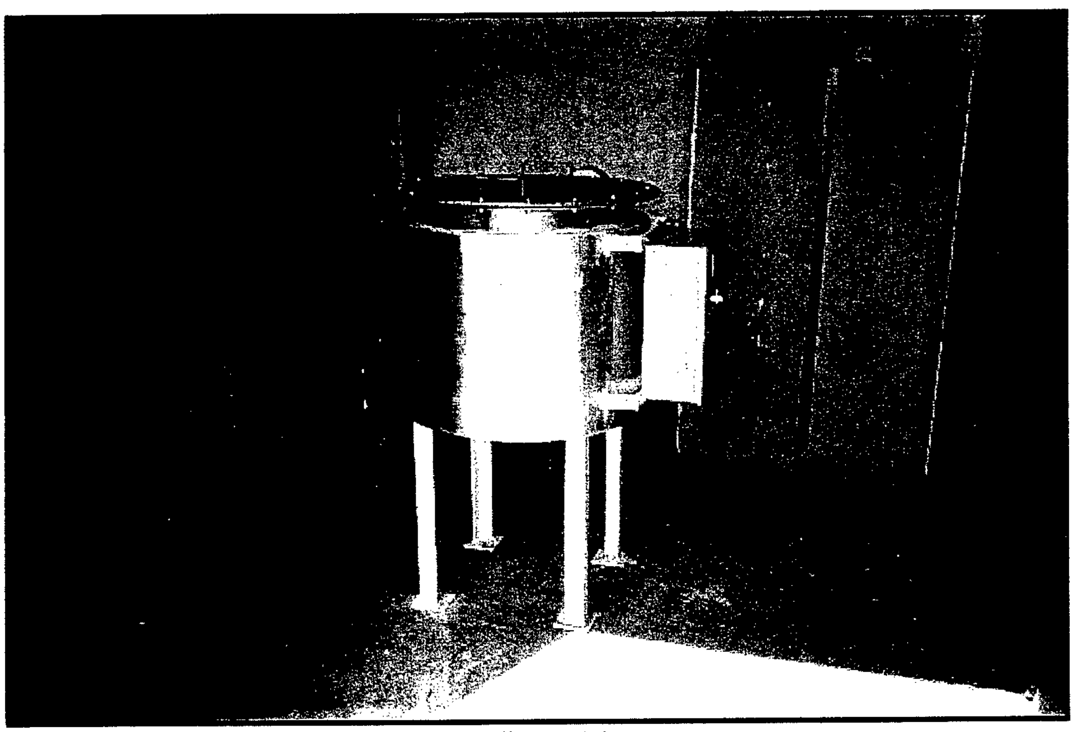
PHOTOS 7 & 8



10 lb/day ozone generator (right) with power supply and control panel (left).



Ozone destruct unit, not yet connected to off-gas piping.

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CORNHUSKER ARMY AMMUNITION PLANT
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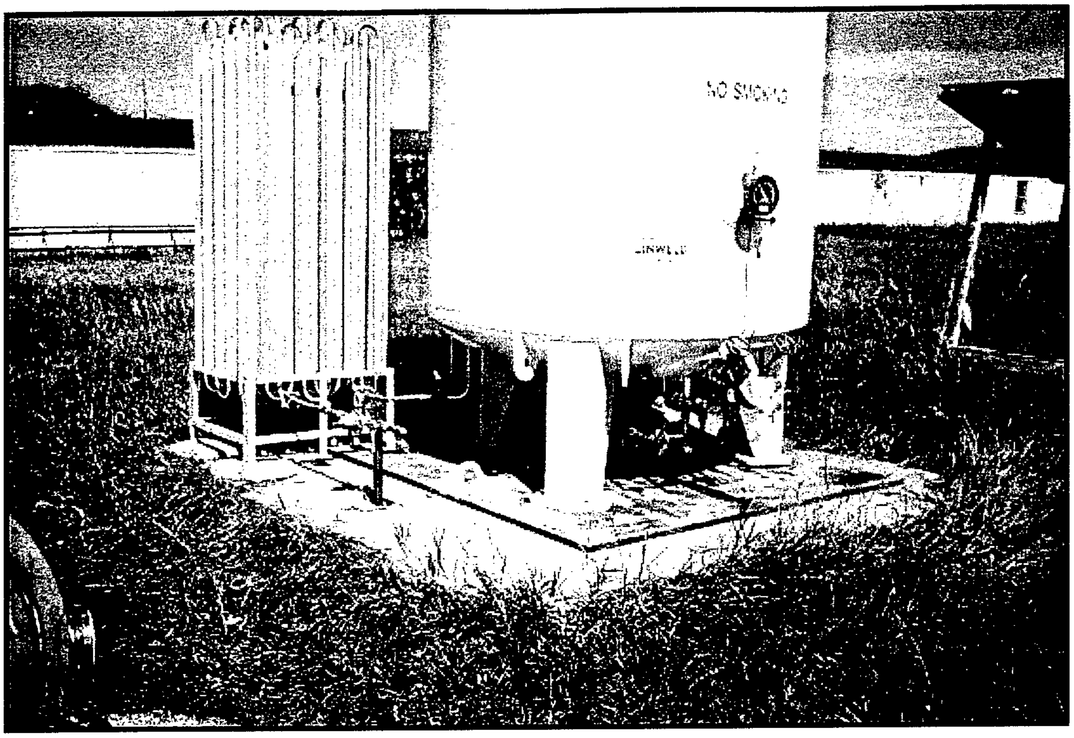
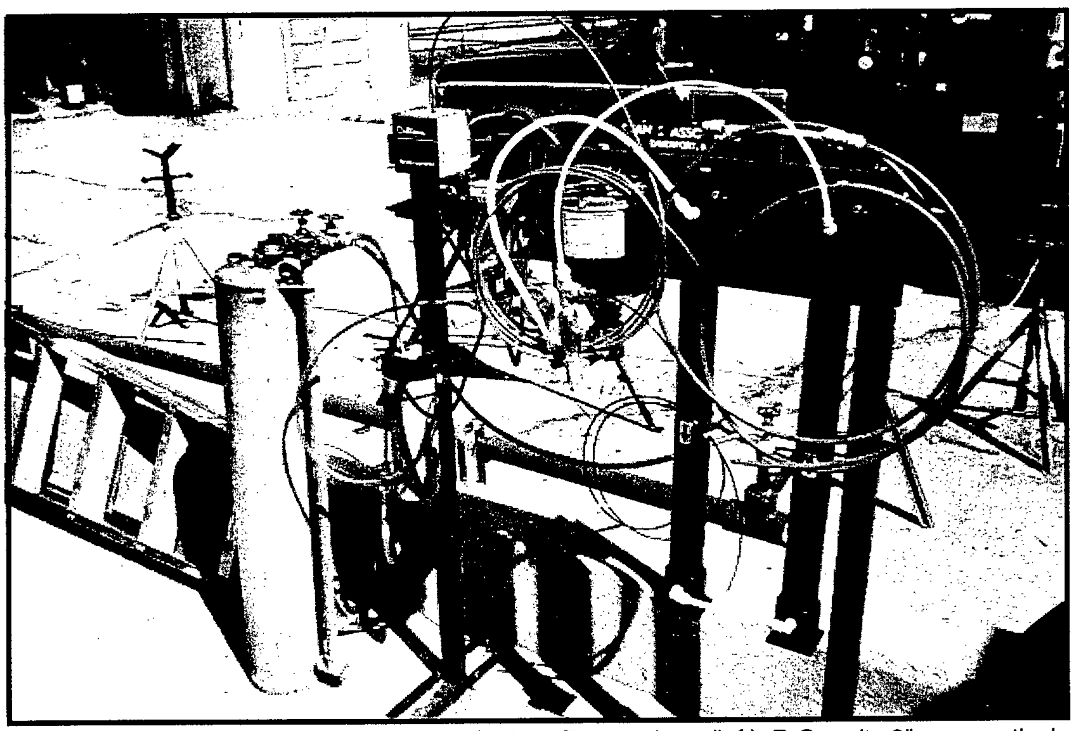
PHOTOS 9 & 10



Leased liquid oxygen storage tank (right), oxygen evaporator (left), supplied by Linweld Oxygen.



Reverse osmosis water purification unit. Carbon filter canister (left), R.O. units 2" gray vertical piping (right center).

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CORNHUSKER ARMY AMMUNITION PLANT
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PHOTOS 11 & 12

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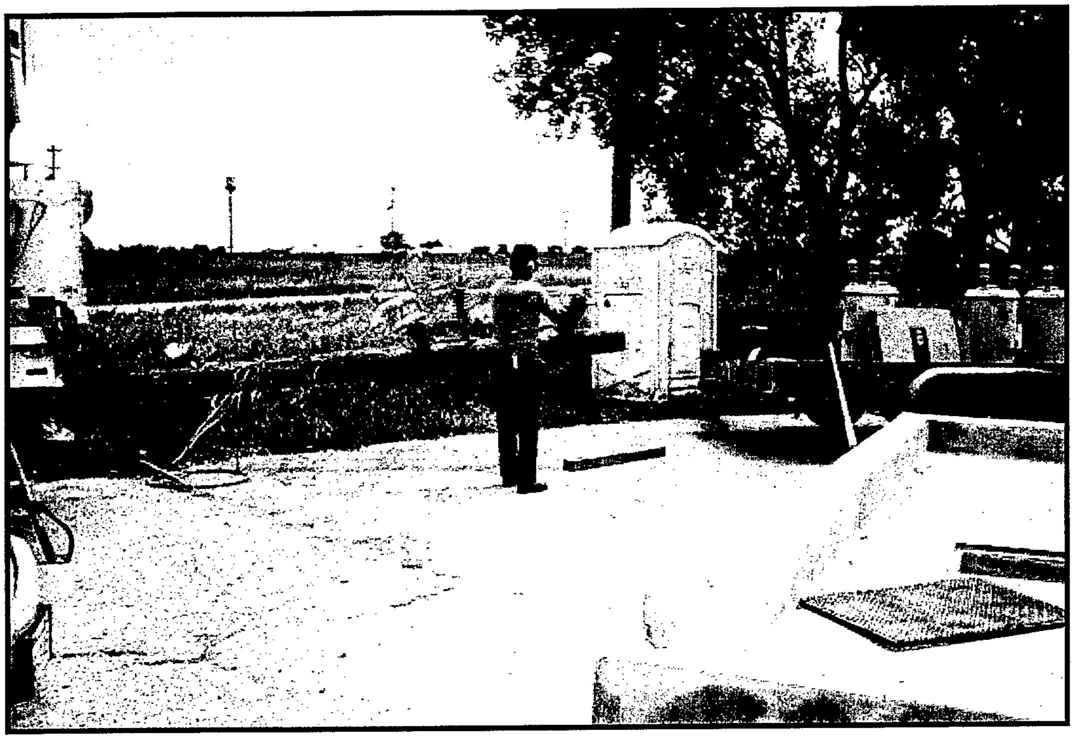
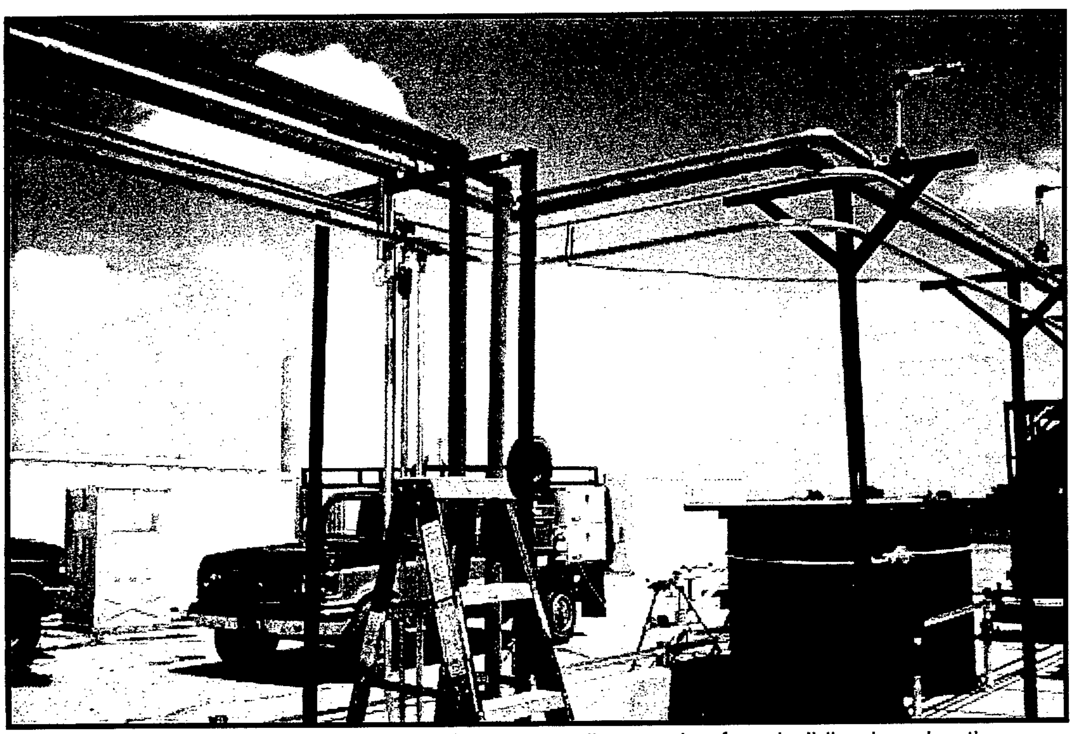


Power company installing 480 volt, three phase transformers with pole.



Conveyance piping, power conduits, influent water line coming from building housing the ozone generator to the treatment pad.

CORNHUSKER ARMY AMMUNITION PLANT
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PHOTOS 13 & 14

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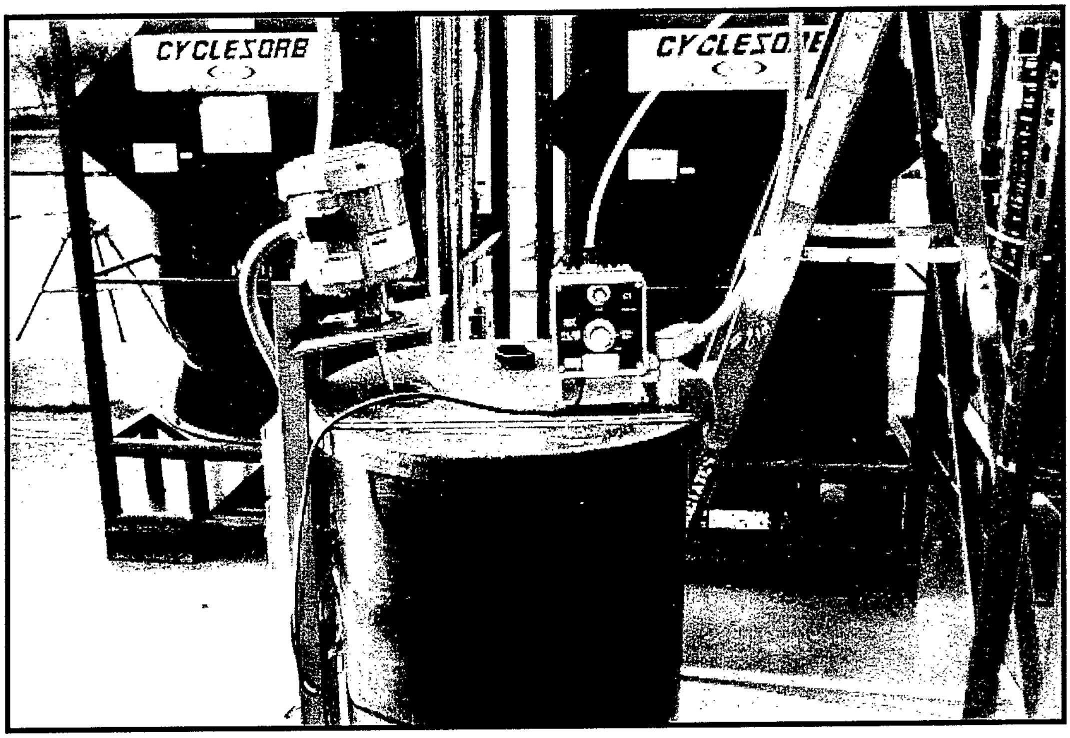
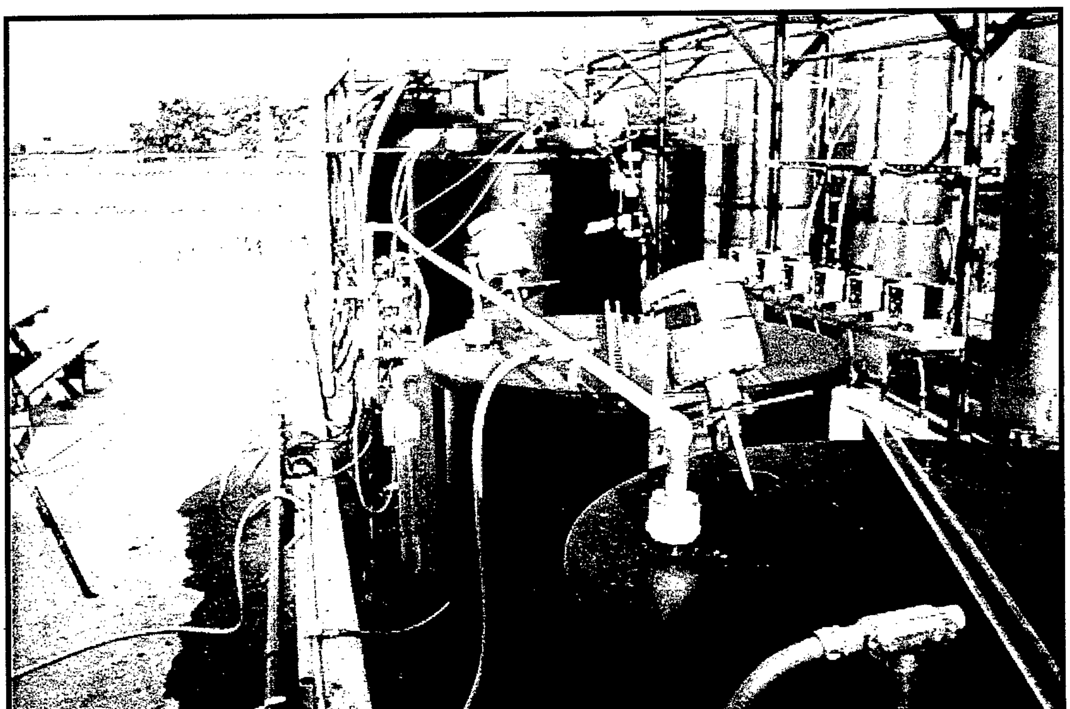


Sodium thiosulfate day tank with chemical metering pump and mixer.



Hydrogen peroxide day tanks (right-center foreground) with mixers and R.O. water supply connections.

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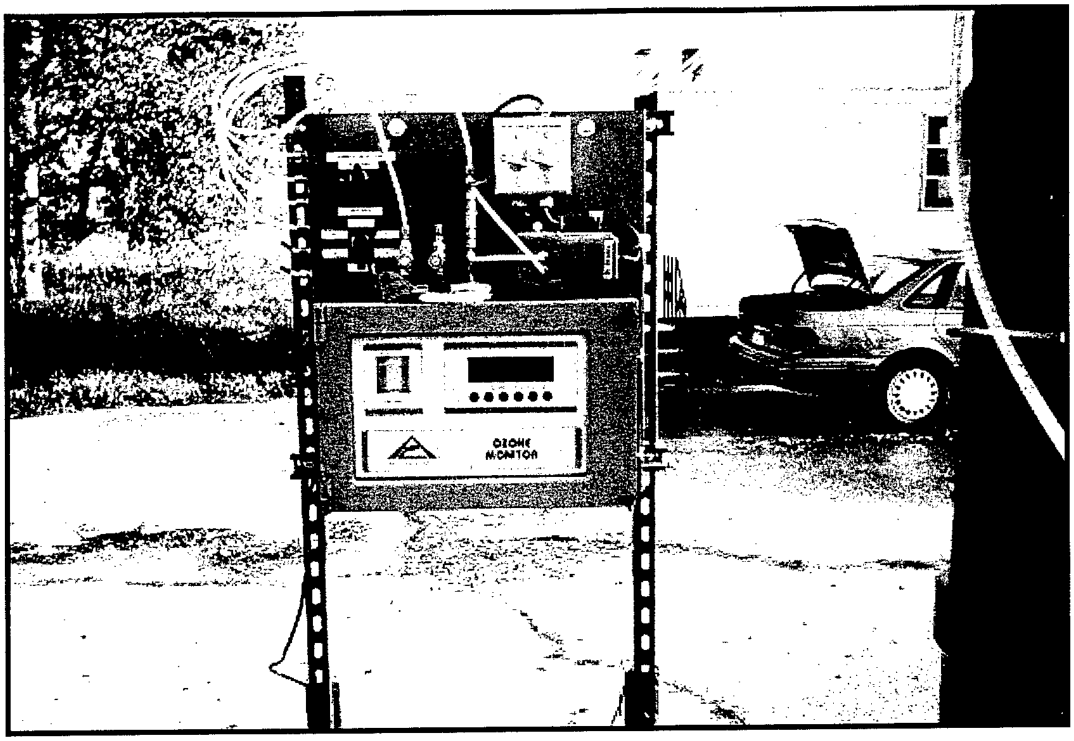
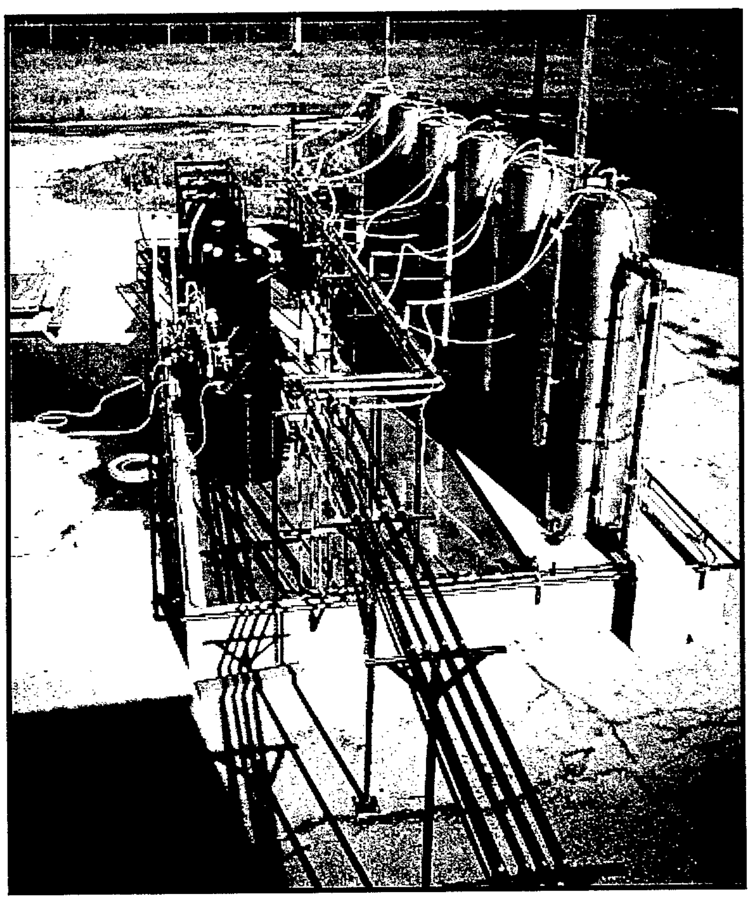
CORNHUSKER ARMY AMMUNITION PLANT
GRAND ISLAND, NEBRASKA
PHOTOS 15 & 16



Ozone analyzer, showing connection tubing from ozone delivery lines. Contactor off-gas lines and oxygen supply line.



Completed peroxone demonstration system.

CORNHUSKER ARMY AMMUNITION PLANT
GRAND ISLAND, NEBRASKA
PHOTOS 17 & 18

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Appendix B

Peroxone System OptimizationTesting Data

PEROXONE Demonstration Plant Optimization Task Test Conditions and Results

Date	Test	Location	Well	Water Flow (gpm)	Contactor HRT (min)	Contactor Applied Ozone (mg/L)	Contactor Transferred Ozone (mg/L)	Contactor Peroxide Dose (mg/L)	PEROXONE Ratio	Ozone Residual (mg/L)	TNB (µg/L)	TNT (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-dinitro-benzene (µg/L)	2,4-dinitro-toluene (µg/L)	2,6-dinitro-toluene (µg/L)	2-Amino-4,6-dinitro-toluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-donitro-toluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
8/28/96	0201	INF1	1	25.0							428	731	45	1560	5.71	2.2	BQL	BQL	BQL	BQL	BQL	331	BQL	10.8	BQL	14.3
8/28/96	0201	INF2	1	25.0							711	1200	73	2570	3.9	3.3	BQL	BQL	BQL	BQL	BQL	538	BQL	25.4	BQL	18
8/28/96	0201	INF3	1	25.0							498	800	74	2130	2.88	BQL	BQL	BQL	317	BQL	BQL	416	BQL	14.5	BQL	13.9
8/28/96	0201	C1/2	1	25.0	23.9	60.0	37.0	14.5	0.39	2.7	564	789	39	1410	0.207	0.6	0.4	0.8	BQL	BQL	BQL	BQL	BQL	18.3	BQL	2.1
8/28/96	0201	C1/4	1	25.0	23.9	60.0	37.0	14.5	0.39	2.2	429	548	57	1120	0.187	0.5	0.4	0.7	BQL	BQL	BQL	BQL	BQL	78.9	BQL	2.3
8/28/96	0201	C1/6	1	25.0	23.9	60.0	37.0	14.5	0.39	2.6	721	800	125	1800	0.374	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	147	BQL	2.8
8/28/96	0201	C1/8	1	25.0	23.9	60.0	37.0	14.5	0.39	2.1	705	752	55	1530	0.382	0.4	0.2	0.4	BQL	BQL	BQL	BQL	BQL	13	BQL	1.8
8/28/96	0201	C1/0	1	25.0	23.9	60.0	37.0	14.5	0.39	1.8	330	342	34	719	3.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	11.9	BQL	1.1
8/28/96	0201	C2/0	1	25.0	23.9	60.0	35.0	14.5	0.41	1.2	179	111	1.2	292	1.98	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	0.1
8/28/96	0201	C3/0	1	25.0	23.9	60.0	38.0	14.5	0.38	2.8	100	36.1	5.2	146	1.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.7	BQL	0.2
8/28/96	0201	C4/0	1	25.0	23.9	60.0	37.0	14.5	0.39	2.0	53	9.2	1.6	66.9	1.08	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.1	BQL	BQL
8/28/96	0201	C5/0	1	25.0	23.9	60.0	35.0	14.5	0.41	1.2	34.3	3.8	0.9	41.7	1.8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.7	BQL	BQL
8/28/96	0201	C6/01	1	25.0	23.9	60.0	37.0	14.5	0.39	2.7	18.7	1.2	0.4	22.3	0.302	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2	BQL	BQL
8/28/96	0201	C6/02	1	25.0	23.9	60.0	37.0	14.5	0.39		26.1	1.3	0.6	29.9	0.384	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.9	BQL	BQL
8/28/96	0201	GAC1	1								BQL	BQL	BQL	BQL	0.675	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
8/31/96	0202	INF1	1	18.0							413	616	42	1350	1.9	1.5	BQL	14.4	BQL	BQL	BQL	246	BQL	10.4	BQL	8
8/31/96	0202	C1/2	1	18.0	33.2	65.0	53.0	15.0	0.28	1.5	154	122	12	299	2.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	10.2	BQL	0.3
8/31/96	0202	C1/4	1	18.0	33.2	65.0	53.0	15.0	0.28	1.4	233	181	18	440	2.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.6	BQL	0.4
8/31/96	0202	C1/6	1	18.0	33.2	65.0	53.0	15.0	0.28	1.1	206	156	15	384	2.19	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.5	BQL	0.3
8/31/96	0202	C1/8	1	18.0	33.2	65.0	53.0	15.0	0.28	1.0	108	83	17	216	2.15	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.7	BQL	0.4
8/31/96	0202	C1/0	1	18.0	33.2	65.0	53.0	15.0	0.28	0.8	150	113	12	280	2.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.3	BQL	BQL
8/31/96	0202	C2/0	1	18.0	33.2	65.0	46.0	15.0	0.33	2.9	45.1	36.1	3.2	86.3	2.32	0.1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
8/31/96	0202	C3/0	1	18.0	33.2	65.0	48.0	15.0	0.31	4.9	10	8.9	0.4	19.8	2.35	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
8/31/96	0202	C4/0	1	18.0	33.2	65.0	48.0	15.0	0.31	3.0	8.9	1.9	0.3	11.5	3.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
8/31/96	0202	C5/0	1	18.0	33.2	65.0	41.0	15.0	0.37	2.0	13.2	0.7	0.2	15.1	2.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
8/31/96	0202	C6/01	1	18.0	33.2	65.0	51.0	15.0	0.29	0.8	6.4	0.2	BQL	7.3	2.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
8/31/96	0202	C6/02	1	18.0	33.2	65.0	51.0	15.0	0.29		2.5	0.2	BQL	2.7	2.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
8/31/96	0202	GAC3	1								BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
8/30/96	0203	INF1	1	18.0							513	823	59	1820	1.98	2.3	BQL	22.6	BQL	BQL	BQL	369	BQL	14.7	BQL	11.5
8/30/96	0203	INF2	1	18.0							134	517	48	978	1.92	1.8	BQL	23	BQL	BQL	BQL	230	BQL	15.9	BQL	9.2
8/30/96	0203	INF3	1	18.0							497	789	63	1750	19.4	BQL	BQL	BQL	BQL	BQL	BQL	374	BQL	14.1	BQL	15.2
8/30/96	0203	C1/2	1	18.0	33.2	85.0	66.0	18.0	0.27	2.7	252	221	18	500	2.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	8	BQL	0.6
8/30/96	0203	C1/4	1	18.0	33.2	85.0	66.0	18.0	0.27	2.2	184	149	16	362	2.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.9	BQL	0.9
8/30/96	0203	C1/6	1	18.0	33.2	85.0	66.0	18.0	0.27	2.6	125	109	11	249	2.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.8	BQL	0.3
8/30/96	0203	C1/8	1	18.0	33.2	85.0	66.0	18.0	0.27	2.1	Brkn	Brkn	Brkn	Brkn	2.17	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn
8/30/96	0203	C1/0	1	18.0	33.2	85.0	66.0	18.0	0.27	1.8	335	294	26	667	2.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	10.7	BQL	0.9
8/30/96	0203	C2/0	1	18.0	33.2	85.0	58.0	18.0	0.31	1.2	54.7	41.4	4.6	109	2.4	BQL	BQL	BQL	BQL	BQL	BQL	4.6	BQL	3.1	0.3	BQL
8/30/96	0203	C3/0	1	18.0	33.2	85.0	56.0	18.0	0.32	2.8	17.6	7.4	0.7	29.6	2.46	BQL	BQL	BQL	BQL	BQL	BQL	2.5	BQL	1.2	0.2	BQL
8/30/96	0203	C4/0	1	18.0	33.2	85.0	56.0	18.0	0.32	2.0	10	1.9	0.4	17	2.5	BQL	BQL	BQL	BQL	BQL	BQL	3.7	BQL	0.8	0.2	BQL
8/30/96	0203	C5/0	1	18.0	33.2	85.0	52.0	18.0	0.35	1.2	Brkn	Brkn	Brkn	Brkn	2.65	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn

PEROXONE Demonstration Plant Optimization Task Test Conditions and Results

Date	Test	Location	Well	Water Flow (gpm)	Contactor HRT (min)	Contactor Applied Ozone (mg/L)	Contactor Transferred Ozone (mg/L)	Contactor Peroxide Dose (mg/L)	PEROXONE Ratio	Ozone Residual (mg/L)	TNB (µg/L)	TNT (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-dinitro-benzene (µg/L)	2,4-dinitro-toluene (µg/L)	2,6-dinitro-toluene (µg/L)	2-Amino-4,6-dinitro-toluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-donitro-toluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
8/30/96	0203	C6/01	1	18.0	33.2	85.0	52.0	18.0	0.35	2.7	4.7	0.1	BQL	6.6	2.71	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL	BQL	BQL
8/30/96	0203	C6/02	1	18.0	33.2	85.0	52.0	18.0	0.35		4.3	BQL	BQL	4.8	2.74	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL	BQL	BQL
8/30/96	0203	GAC3	1								BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/3/96	0204	INF1	1	13.0							498	692	55	1510	7.92	1.9	BQL	BQL	BQL	BQL	BQL	242	BQL	7.5	BQL	10.8
9/3/96	0204	C1/2	1	13.0	46.0	115.0	87.0	22.5	0.26	2.0	180	126	16	330	2.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7	BQL	0.8
9/3/96	0204	C1/4	1	13.0	46.0	115.0	87.0	22.5	0.26	2.7	158	114	15	294	5.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.6	BQL	0.6
9/3/96	0204	C1/6	1	13.0	46.0	115.0	87.0	22.5	0.26	2.2	194	131	16	349	5.99	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.3	BQL	0.6
9/3/96	0204	C1/8	1	13.0	46.0	115.0	87.0	22.5	0.26	2.0	169	131	17	325	6.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.6	BQL	0.6
9/3/96	0204	C1/0	1	13.0	46.0	115.0	87.0	22.5	0.26	1.7	226	155	16	406	10.9	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.7	BQL	0.7
9/3/96	0204	C2/0	1	13.0	46.0	115.0	79.0	22.5	0.28	3.5	59.6	18.2	3.6	85.2	9.71	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.6	BQL	0.2
9/3/96	0204	C3/0	1	13.0	46.0	115.0	87.0	22.5	0.26	2.5	Brkn	Brkn	Brkn	Brkn	8.8	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn
9/3/96	0204	C4/0	1	13.0	46.0	115.0	74.0	22.5	0.30	4.2	11.1	0.6	BQL	12.7	9.94	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/3/96	0204	C5/0	1	13.0	46.0	115.0	74.0	22.5	0.30	2.8	4.2	BQL	BQL	4.8	7.94	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
9/3/96	0204	C6/01	1	13.0	46.0	115.0	79.0	22.5	0.28	3.0	1.8	BQL	BQL	1.8	9.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/3/96	0204	C6/02	1	13.0	46.0	115.0	79.0	22.5	0.28		1.6	BQL	BQL	1.6	8.59	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/3/96	0204	GAC3	1								BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/2/96	0205	INF1	2	18.0							470	536	21	1150	20	BQL	BQL	8	BQL	BQL	BQL	87.3	BQL	5.6	BQL	20.8
9/2/96	0205	INF2	2	18.0							711	626	29	1560	8.52	BQL	BQL	21.2	BQL	BQL	BQL	109	BQL	6.9	24.9	31.4
9/2/96	0205	C1/2	2	18.0	33.2	43.0	34.0	9.0	0.26	0.9	783	278	15	1080	8.94	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	8.9	BQL	BQL
9/2/96	0205	C1/4	2	18.0	33.2	43.0	34.0	9.0	0.26	0.9	395	226	15	646	7.36	BQL	BQL	1.2	BQL	BQL	BQL	BQL	BQL	9	BQL	BQL
9/2/96	0205	C1/6	2	18.0	33.2	43.0	34.0	9.0	0.26	0.9	545	309	20	887	8.81	BQL	BQL	1.5	BQL	BQL	BQL	BQL	BQL	11.3	BQL	BQL
9/2/96	0205	C1/8	2	18.0	33.2	43.0	34.0	9.0	0.26	0.9	411	243	15	679	8.79	BQL	BQL	1.2	BQL	BQL	BQL	BQL	BQL	8.5	BQL	BQL
9/2/96	0205	C1/0	2	18.0	33.2	43.0	34.0	9.0	0.26	0.7	333	197	12	549	9.81	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7	BQL	BQL
9/2/96	0205	C2/0	2	18.0	33.2	43.0	27.0	9.0	0.33	2.9	223	92.8	5.1	325	7.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.9	BQL	BQL
9/2/96	0205	C3/0	2	18.0	33.2	43.0	29.0	9.0	0.31	2.2	149	37.3	2.6	192	6.89	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.9	BQL	BQL
9/2/96	0205	C4/0	2	18.0	33.2	43.0	24.0	9.0	0.38	3.8	39	16.6	0.7	57.5	8.42	0.1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
9/2/96	0205	C5/0	2	18.0	33.2	43.0	24.0	9.0	0.38	2.5	85.7	9.1	0.8	98.1	10.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.5	BQL	BQL
9/2/96	0205	C6/01	2	18.0	33.2	43.0	26.0	9.0	0.35	2.7	46.9	2.5	BQL	51.1	8.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
9/2/96	0205	C6/02	2	18.0	33.2	43.0	26.0	9.0	0.35		23.7	1.6	BQL	26	8.89	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
9/2/96	0205	GAC3	2								BQL	BQL	BQL	BQL	10.1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
8/31/96	0206	INF1	2	18.0							114	439	28	755	13.4	1	BQL	21.5	BQL	BQL	BQL	120	BQL	5.5	BQL	26.1
8/31/96	0206	INF2	2	18.0							202	594	30	1040	12.3	1.4	BQL	25.9	BQL	BQL	BQL	143	BQL	7	BQL	33.7
8/31/96	0206	C1/2	2	18.0	33.2	65.0	52.0	15.0	0.29	0.9	14.8	20.3	1.7	38.5	37.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
8/31/96	0206	C1/4	2	18.0	33.2	65.0	52.0	15.0	0.29	1.1	17	21.3	1.6	41.6	11.8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
8/31/96	0206	C1/6	2	18.0	33.2	65.0	52.0	15.0	0.29	1.2	15.9	21.2	1.9	40.7	11.8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
8/31/96	0206	C1/8	2	18.0	33.2	65.0	52.0	15.0	0.29	0.9	Brkn	Brkn	Brkn	Brkn	12.1	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn
8/31/96	0206	C1/0	2	18.0	33.2	65.0	52.0	15.0	0.29	0.7	3	3.2	0.2	6.7	12.8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.3	BQL	BQL
8/31/96	0206	C2/0	2	18.0	33.2	65.0	45.0	15.0	0.33	2.4	17	14.2	1.3	34.2	12.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
8/31/96	0206	C3/0	2	18.0	33.2	65.0	49.0	15.0	0.31	1.5	3.2	1.1	BQL	4.8	13.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
8/31/96	0206	C4/0	2	18.0	33.2	65.0	44.0	15.0	0.34	2.8	Brkn	Brkn	Brkn	Brkn	13.3	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn

PEROXONE Demonstration Plant Optimization Task Test Conditions and Results

Date	Test	Location	Well	Water Flow (gpm)	Contactor HRT (min)	Contactor Applied Ozone (mg/L)	Contactor Transferred Ozone (mg/L)	Contactor Peroxide Dose (mg/L)	PEROXONE Ratio	Ozone Residual (mg/L)	TNB (µg/L)	TNT (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-dinitro-benzene (µg/L)	2,4-dinitro-toluene (µg/L)	2,6-dinitro-toluene (µg/L)	2-Amino-4,6-dinitro-toluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitro-toluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
8/31/96	0206	C5/0	2	18.0	33.2	65.0	37.0	15.0	0.41	3.8	5.4	2.1	0.2	8.7	12.9	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
8/31/96	0206	C6/01	2	18.0	33.2	65.0	52.0	15.0	0.29	1.2	1	BQL	BQL	1.3	12.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.3	BQL	BQL
8/31/96	0206	GAC31	2								BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
8/31/96	0206	GAC32	2								BQL	BQL	BQL	BQL	0.236	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/1/96	0207	INF1	2	18.0							195	446	28	818	5.42	BQL	BQL	13.9	BQL	BQL	BQL	103	BQL	5.2	BQL	27.5
9/1/96	0207	INF2	2	18.0							512	645	20	1330	4.3	BQL	BQL	11.8	BQL	BQL	BQL	113	BQL	5	BQL	22.6
9/1/96	0207	INF3	2	18.0							461	508	24	1120	6.37	BQL	BQL	6.5	BQL	BQL	BQL	89.7	BQL	5.3	BQL	24.8
9/1/96	0207	C1/2	2	18.0	33.2	85.0	67.0	18.0	0.27	1.5	200	134	15	359	5.95	0.1	BQL	0.6	BQL	BQL	BQL	BQL	BQL	8.8	BQL	0.8
9/1/96	0207	C1/4	2	18.0	33.2	85.0	67.0	18.0	0.27	2.0	187	113	7.8	313	4.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.9	BQL	0.5
9/1/96	0207	C1/6	2	18.0	33.2	85.0	67.0	18.0	0.27	2.0	203	123	9.5	342	5.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.5	BQL	0.5
9/1/96	0207	C1/8	2	18.0	33.2	85.0	67.0	18.0	0.27	1.8	Brkn	Brkn	Brkn	Brkn	5.46	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn
9/1/96	0207	C1/0	2	18.0	33.2	85.0	67.0	18.0	0.27	1.0	198	128	8.9	342	5.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.3	BQL	0.9
9/1/96	0207	C2/0	2	18.0	33.2	85.0	57.0	18.0	0.32	3.6	79	28.5	2.5	113	5.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.8	BQL	BQL
9/1/96	0207	C3/0	2	18.0	33.2	85.0	64.0	18.0	0.28	2.2	52	10.4	1	65.6	6.6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.2	BQL	BQL
9/1/96	0207	C4/0	2	18.0	33.2	85.0	58.0	18.0	0.31	4.6	3.3	1.1	0.3	4.9	7.57	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.2	BQL	BQL
9/1/96	0207	C5/0	2	18.0	33.2	85.0	50.0	18.0	0.36	4.5	2.1	0.4	BQL	2.5	5.73	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/1/96	0207	C6/01	2	18.0	33.2	85.0	62.0	18.0	0.29	2.2	4.1	BQL	BQL	4.1	9.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/1/96	0207	C6/02	2	18.0	33.2	85.0	62.0	18.0	0.29		3.9	BQL	BQL	3.9	4.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/1/96	0207	GAC3	2								0.7	0.4	BQL	1.1	4.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/2/96	0208	INF1	2	13.0							370	335	14	776	7.16	BQL	BQL	BQL	BQL	BQL	BQL	52.6	BQL	3.8	BQL	BQL
9/2/96	0208	INF2	2	13.0							546	508	28	1200	8.57	0.9	BQL	9.1	BQL	BQL	BQL	82.9	BQL	7.6	BQL	23
9/2/96	0208	C1/2	2	13.0	46.0	115.0	90.0	22.5	0.25	1.8	177	110	6.6	298	8.01	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.4	BQL	BQL
9/2/96	0208	C1/4	2	13.0	46.0	115.0	90.0	22.5	0.25	2.5	126	89	4.6	223	10.9	0.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.3	BQL	BQL
9/2/96	0208	C1/6	2	13.0	46.0	115.0	90.0	22.5	0.25	2.0	154	97.3	5	260	7.41	0.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.6	BQL	BQL
9/2/96	0208	C1/8	2	13.0	46.0	115.0	90.0	22.5	0.25	1.8	168	102	6.1	280	8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.8	BQL	BQL
9/2/96	0208	C1/0	2	13.0	46.0	115.0	90.0	22.5	0.25	1.4	252	111	7.8	376	9.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.3	BQL	0.4
9/2/96	0208	C2/0	2	13.0	46.0	115.0	78.0	22.5	0.29	3.5	34.5	14.1	0.9	50.7	9.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.2	BQL	BQL
9/2/96	0208	C3/0	2	13.0	46.0	115.0	85.0	22.5	0.26	3.0	17	3.3	0.4	21.6	8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
9/2/96	0208	C4/0	2	13.0	46.0	115.0	71.0	22.5	0.32	4.3	Brkn	Brkn	Brkn	Brkn	9.77	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn	Brkn
9/2/96	0208	C5/0	2	13.0	46.0	115.0	76.0	22.5	0.30	2.2	5	0.2	BQL	5.2	9.85	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/2/96	0208	C6/01	2	13.0	46.0	115.0	79.0	22.5	0.28	3.3	1.7	BQL	BQL	1.7	9.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/10/96	0209	INF1	1	13.0							466	803	56	1750	1.84	BQL	BQL	27.3	BQL	BQL	BQL	378	BQL	13.9	BQL	10.3
9/10/96	0209	INF2	1	13.0							380	616	52	1360	1.98	BQL	BQL	21.5	BQL	BQL	BQL	270	BQL	8.2	BQL	9.2
9/10/96	0209	INF3	1	13.0							456	683	45	1520	2.21	BQL	BQL	20.4	BQL	BQL	BQL	302	BQL	10	BQL	9
9/10/96	0209	C1/2	1	13.0	46.0	38.0	32.0	16.9	0.53	0.0	280	245	87	626	1.94	BQL	BQL	0.7	BQL	BQL	BQL	2.3	BQL	10	BQL	0.7
9/10/96	0209	C1/4	1	13.0	46.0	38.0	32.0	16.9	0.53	0.0	289	254	89	647	2.12	0.2	BQL	0.9	BQL	BQL	BQL	2.1	BQL	11.4	BQL	0.8
9/10/96	0209	C1/6	1	13.0	46.0	38.0	32.0	16.9	0.53	0.0	269	230	89	598	2.19	BQL	BQL	0.4	BQL	BQL	BQL	0.5	BQL	9.3	BQL	0.7
9/10/96	0209	C1/8	1	13.0	46.0	38.0	32.0	16.9	0.53	0.0	274	239	82	612	2.15	0.1	BQL	1	BQL	BQL	BQL	3.6	BQL	10.9	BQL	0.8
9/10/96	0209	C1/0	1	13.0	46.0	38.0	32.0	16.9	0.53	0.0	260	232	78	583	2.21	0.1	BQL	0.8	BQL	BQL	BQL	2.8	BQL	8.8	BQL	0.6
9/10/96	0209	C2/0	1	13.0	46.0	38.0	32.0	16.9	0.53	0.2	264	152	75	501	2.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	9.2	BQL	0.5

PEROXONE Demonstration Plant Optimization Task Test Conditions and Results

Date	Test	Location	Well	Water Flow (gpm)	Contactor HRT (min)	Contactor Applied Ozone (mg/L)	Contactor Transferred Ozone (mg/L)	Contactor Peroxide Dose (mg/L)	PEROXONE Ratio	Ozone Residual (mg/L)	TNB (µg/L)	TNT (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-dinitro-benzene (µg/L)	2,4-dinitro-toluene (µg/L)	2,6-dinitro-toluene (µg/L)	2-Amino-4,6-dinitro-toluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-donitro-toluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/10/96	0209	C3/0	1	13.0	46.0	38.0	32.0	16.9	0.53	0.2	100	38.6	18	162	2.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5	BQL	BQL
9/10/96	0209	C4/0	1	13.0	46.0	38.0	30.0	16.9	0.56	0.3	48.3	13	3.8	68.4	2.52	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.3	BQL	BQL
9/10/96	0209	C5/0	1	13.0	46.0	38.0	31.0	16.9	0.55	0.2	29.6	3.8	0.8	36.4	2.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.2	BQL	BQL
9/10/96	0209	C6/01	1	13.0	46.0	38.0	31.0	16.9	0.55	0.2	22.3	1.8	0.7	26.4	2.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
9/10/96	0209	C6/02	1	13.0	46.0	38.0	31.0	16.9	0.55		15	1.2	BQL	17.6	2.42	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.4	BQL	BQL
9/10/96	0209	GAC3	1								0.8	1.1	BQL	2.3	6.83	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL	BQL	BQL
9/10/96	0210	INF1	1	13.0							451	631	45	1420	2.12	BQL	BQL	23.4	BQL	BQL	BQL	250	BQL	7.9	BQL	8.9
9/10/96	0210	INF2	1	13.0							439	624	48	1400	1.87	1.1	BQL	22	BQL	BQL	BQL	253	BQL	6.9	BQL	9
9/10/96	0210	C1/2	1	13.0	46.0	56.0	45.0	19.8	0.44	0.1	216	170	20	414	2.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.2	BQL	0.7
9/10/96	0210	C1/4	1	13.0	46.0	56.0	45.0	19.8	0.44	0.3	180	134	15	337	2.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.6	BQL	0.7
9/10/96	0210	C1/6	1	13.0	46.0	56.0	45.0	19.8	0.44	0.4	279	218	22	528	2.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	8.5	BQL	0.9
9/10/96	0210	C1/8	1	13.0	46.0	56.0	45.0	19.8	0.44	0.3	243	186	21	460	2.25	BQL	BQL	0.5	BQL	BQL	BQL	BQL	BQL	8.6	BQL	1
9/10/96	0210	C1/0	1	13.0	46.0	56.0	45.0	19.8	0.44	0.1	221	166	18	414	2.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	7.8	BQL	0.5
9/10/96	0210	C2/0	1	13.0	46.0	56.0	42.0	19.8	0.47	0.4	102	42.1	6	155	2.19	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.8	BQL	0.2
9/10/96	0210	C3/0	1	13.0	46.0	56.0	40.0	19.8	0.50	0.8	39.7	11.9	1.7	56	2.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.7	BQL	BQL
9/10/96	0210	C4/0	1	13.0	46.0	56.0	40.0	19.8	0.50	0.8	27.8	3.7	0.7	34.2	2.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2	BQL	BQL
9/10/96	0210	C5/0	1	13.0	46.0	56.0	40.0	19.8	0.50	0.7	12.9	1	BQL	14.9	2.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/10/96	0210	C6/01	1	13.0	46.0	56.0	45.0	19.8	0.44	0.1	5.6	0.3	BQL	6.4	2.71	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/10/96	0210	C6/02	1	13.0	46.0	56.0	45.0	19.8	0.44		6.8	0.3	BQL	8	2.9	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL

Appendix C

Peroxone System Demonstration Testing Data

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 1

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/13/96	1	13	115	92	42.5	0.46	INF1	16:00		7.0	17	324				642	464	43.9	1370	2.14	BQL	13.2	BQL	194	BQL	BQL	BQL	BQL	13.1	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	INF1	18:00								427	313	40.1	994	2.67	BQL	12.7	BQL	181	BQL	BQL	BQL	BQL	12	BQL	8.6
9/13/96	1	13	115	92	42.5	0.46	INF1									672	486	46.9	1440	2.61	BQL	14.1	BQL	198	BQL	BQL	BQL	BQL	8.3	BQL	10.2
9/13/96	1	13	115	92	42.5	0.46	INF1									432	316	30.9	929	2.69	BQL	9.6	BQL	129	BQL	BQL	BQL	BQL	4.5	BQL	6.9
9/13/96	1	13	115	92	42.5	0.46	C1/0	15:52	0.0	7.2	18	251	1.5	98		67.2	104	14.3	192	2.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.2	BQL	0.4
9/13/96	1	13	115	92	42.5	0.46	C1/0	18:00					1.7	96																	
9/13/96	1	13	115	92	42.5	0.46	C2/0	15:48	0.2	7.4	17	514	1.7	96		8.8	31.1	1.4	43.1	2.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C2/0	18:00					2.0	92																	
9/13/96	1	13	115	92	42.5	0.46	C3/0	15:44	0.2	7.5		313	1.7	96		1.4	11.1	0.4	13.9	2.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C3/0	18:00					1.9	93																	
9/13/96	1	13	115	92	42.5	0.46	C4/0	15:38	0.6	7.7		532	2.0	92		0.2	3.3	BQL	3.5	2.99	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C4/0	18:00					2.2	90																	
9/13/96	1	13	115	92	42.5	0.46	C5/0	15:32	0.3	7.9		521	1.8	95		BQL	1.1	BQL	1.1	2.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C5/0	18:00					2.2	90																	
9/13/96	1	13	115	92	42.5	0.46	C6/0	15:27	0.1	8.0		427	1.7	96		BQL	0.4	BQL	0.4	3.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C6/0	18:00					1.9	93		BQL	0.4	BQL	0.4	3.16	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	C6/0									BQL	0.4	BQL	0.4	3.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/13/96	1	13	115	92	42.5	0.46	GAC3									BQL	BQL	BQL	BQL	5.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	INF1	08:18		7.0	13	356				661	475	47.7	1410	1.98	BQL	15.2	BQL	192	BQL	BQL	BQL	BQL	11.3	BQL	9.8
9/14/96	1	13	100	85	41.1	0.48	INF1									618	464	43.4	1330	2.22	BQL	14.3	BQL	179	BQL	BQL	BQL	BQL	6.1	BQL	8.9
9/14/96	1	13	100	85	41.1	0.48	INF1	14:16		7.0	14	275				657	493	43.7	1400	1.95	BQL	14.6	BQL	180	BQL	BQL	BQL	BQL	5.6	BQL	8.6
9/14/96	1	13	100	85	41.1	0.48	INF1									426	330	23.4	926	2.38	BQL	10.8	BQL	125	BQL	BQL	BQL	BQL	4.5	BQL	6.7
9/14/96	1	13	100	85	41.1	0.48	C1/0	08:20	0.0	7.2	13	226	1.0	89		114	170	43.4	335	2.16	BQL	0.2	BQL	0.7	BQL	BQL	BQL	BQL	6.4	BQL	0.5
9/14/96	1	13	100	85	41.1	0.48	C1/0	10:48	0.0																						
9/14/96	1	13	100	85	41.1	0.48	C1/0	13:15	0.0	7.2	14	223	1.2	86																	
9/14/96	1	13	100	85	41.1	0.48	C1/0	15:31	0.2																						
9/14/96	1	13	100	85	41.1	0.48	C2/0	08:28	0.0	7.4	13	216	0.9	89		21.6	60	8.7	93.5	2.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.2	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C2/0	10:54	0.0																						
9/14/96	1	13	100	85	41.1	0.48	C2/0	13:35	0.0	7.4	14	216	1.2	86																	
9/14/96	1	13	100	85	41.1	0.48	C2/0	15:33	0.1																						
9/14/96	1	13	100	85	41.1	0.48	C3/0	08:40	0.0	7.6		212	0.9	89		4.2	19.5	1.1	26.5	2.54	BQL	BQL	BQL	0.3	BQL	BQL	BQL	BQL	1.4	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C3/0	10:57	0.0																						
9/14/96	1	13	100	85	41.1	0.48	C3/0	13:45	0.0	7.7	14	205	1.3	85																	
9/14/96	1	13	100	85	41.1	0.48	C3/0	15:36	0.3																						
9/14/96	1	13	100	85	41.1	0.48	C4/0	08:45	0.3	7.7	13	516	1.2	86		0.4	5.1	BQL	6.6	2.72	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C4/0	10:59	0.1																						
9/14/96	1	13	100	85	41.1	0.48	C4/0	13:52	0.0	7.8	14	207	1.5	83																	
9/14/96	1	13	100	85	41.1	0.48	C4/0	15:39	0.6																						
9/14/96	1	13	100	85	41.1	0.48	C5/0	08:56	2.7	7.9	14	944	1.9	78		0.1	2.2	BQL	3.1	2.8	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C5/0	11:00	0.0																						
9/14/96	1	13	100	85	41.1	0.48	C5/0	14:00	0.0	8.0	14	195	1.6	81																	
9/14/96	1	13	100	85	41.1	0.48	C5/0	15:41	0.2																						
9/14/96	1	13	100	85	41.1	0.48	C6/0	09:05	0.0	8.1	14	219	1.0	88		BQL	0.8	BQL	1.3	2.89	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C6/0	11:05	0.0							BQL	1.1	BQL	1.5	3.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C6/0	14:10	0.0	8.1	14	184	1.4	84		0.2	1	BQL	1.2	2.85	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	C6/0	15:45	0.4							BQL	0.6	BQL	0.6	2.91	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	GAC3	09:15	0.0	8.1	14	301				BQL	BQL	BQL	BQL	3.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	GAC1									BQL	BQL	BQL	BQL	2.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/14/96	1	13	100	85	41.1	0.48	GAC2									BQL	BQL	BQL	BQL	2.83	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	INF1	08:45		7.0	13	277				462	338	41.1	1050	2.38	1.4	13.6	BQL	174	BQL	BQL	BQL	BQL	7.7	BQL	9.3
9/15/96	1	13	95	77	37.1	0.48	INF1									214	168	14.3	469	2.12	BQL	4.6	BQL	60.3	BQL	BQL	BQL	BQL	4.7	BQL	3.1
9/15/96	1	13	95	77	37.1	0.48	INF1	10:59		6.9	14	430				527	410	35.4	1140	2.56	1.1	11.8	BQL	145	BQL	BQL	BQL	BQL	6.5	BQL	8.2
9/15/96	1	13	95	77	37.1	0.48	INF1	15:43		7.1	14	425				660	478	39.6	1370	2.18	1.5	12.9	BQL	165	BQL	BQL	BQL	BQL	7.1	BQL	8.6
9/15/96	1	13	95	77	37.1	0.48	C1/0	09:00	0.0	7.2	13	255	1.5	78		56.2	96.6	10.6	179	2.56	BQL	0.5	BQL	5.2	BQL	BQL	BQL	BQL	9.6	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 1

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/15/96	1	13	95	77	37.1	0.48	C1/0	11:04	0.0	7.1	14	311																			
9/15/96	1	13	95	77	37.1	0.48	C1/0	14:15	0.2	7.1	15	540	1.5	78																	
9/15/96	1	13	95	77	37.1	0.48	C1/0	16:00	0.3	7.1	14	601																			
9/15/96	1	13	95	77	37.1	0.48	C2/0	09:11	0.2	7.4	13	545	1.6	77		9.9	41.1	1.5	54.4	2.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.9	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C2/0	11:12	0.2	7.4	14	566																			
9/15/96	1	13	95	77	37.1	0.48	C2/0	14:26	0.4	7.4	15	831	1.5	78																	
9/15/96	1	13	95	77	37.1	0.48	C2/0	16:10	0.5	7.4	15	932																			
9/15/96	1	13	95	77	37.1	0.48	C3/0	09:22	0.4	7.6	14	646	1.7	76		1.2	10.5	BQL	13	2.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C3/0	11:32	0.5	7.6	14	871																			
9/15/96	1	13	95	77	37.1	0.48	C3/0	14:35	0.6	7.6	15	850	1.6	77																	
9/15/96	1	13	95	77	37.1	0.48	C3/0	16:20	0.7	7.6	14	926																			
9/15/96	1	13	95	77	37.1	0.48	C4/0	09:40	0.7	7.7	14	879	1.6	77		0.2	3.5	BQL	4.6	2.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C4/0	11:42	0.9	7.8	14	934																			
9/15/96	1	13	95	77	37.1	0.48	C4/0	15:15	0.7	7.7	14	936	1.8	74																	
9/15/96	1	13	95	77	37.1	0.48	C4/0	16:28	1.2	7.8	14	943																			
9/15/96	1	13	95	77	37.1	0.48	C5/0	09:50	0.1	7.9	14	534	1.5	78		BQL	1.2	BQL	1.7	2.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C5/0	11:50	0.3	7.9	14	842																			
9/15/96	1	13	95	77	37.1	0.48	C5/0	15:26	0.4	8.0	14	895	1.5	78																	
9/15/96	1	13	95	77	37.1	0.48	C5/0	16:35	0.5	8.0	14	896																			
9/15/96	1	13	95	77	37.1	0.48	C6/0	10:00	0.6	8.0	14	889	1.4	79		BQL	0.5	BQL	0.5	2.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C6/0	11:55	0.5	8.0	14	920				BQL	0.4	BQL	0.4	2.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C6/0	15:35	0.5	8.1	14	910	1.6	77		BQL	0.4	BQL	0.4	2.42	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	C6/0	16:45	0.8	8.0	14	909				BQL	0.5	BQL	0.5	2.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/15/96	1	13	95	77	37.1	0.48	GAC3	10:13	0.0	8.1	13	379				0.3	0.2	BQL	0.5	4.79	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	INF1	08:15		7.1	13	307				456	370	40.3	1020	1.73	BQL	10.6	BQL	124	BQL	BQL	BQL	BQL	10.9	BQL	8.4
9/16/96	1	13	98	76	32.1	0.42	INF1	13:43		7.0	15	403				614	444	49.5	1350	2.02	2.4	16.9	BQL	202	BQL	BQL	BQL	BQL	7.2	BQL	11.4
9/16/96	1	13	98	76	32.1	0.42	INF1									490	365	30.9	1050	2.01	BQL	13.1	BQL	133	BQL	BQL	BQL	BQL	7.3	BQL	7.9
9/16/96	1	13	98	76	32.1	0.42	INF1									433	389	32.3	1010	1.89	BQL	11.1	BQL	127	BQL	BQL	BQL	BQL	9.4	BQL	8.3
9/16/96	1	13	98	76	32.1	0.42	C1/0	08:17	0.3	7.3	13	569	1.7	79		72.7	133	8.6	219	2.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.5	BQL	0.5
9/16/96	1	13	98	76	32.1	0.42	C1/0	10:55	0.3																						
9/16/96	1	13	98	76	32.1	0.42	C1/0	13:52	0.4	7.1	17	837	1.7	79																	
9/16/96	1	13	98	76	32.1	0.42	C1/0	15:53	0.6																						
9/16/96	1	13	98	76	32.1	0.42	C2/0	08:30	0.6	7.4	13	858	1.9	76		9.8	40	1.5	53.1	2.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C2/0	10:58	0.7																						
9/16/96	1	13	98	76	32.1	0.42	C2/0	14:03	0.8	7.3	16	942	1.7	79																	
9/16/96	1	13	98	76	32.1	0.42	C2/0	16:00	1.1																						
9/16/96	1	13	98	76	32.1	0.42	C3/0	08:40	0.8	7.7	13	926	1.9	76		1.7	15.8	0.5	19.4	2.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.4	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C3/0	11:03	1.0																						
9/16/96	1	13	98	76	32.1	0.42	C3/0	14:11	1.4	7.6	16	942	1.7	79																	
9/16/96	1	13	98	76	32.1	0.42	C3/0	16:26	2.1																						
9/16/96	1	13	98	76	32.1	0.42	C4/0	08:47	1.2	7.9	13	943	2.2	73		0.2	4.6	BQL	5.7	2.63	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C4/0	11:06	1.4																						
9/16/96	1	13	98	76	32.1	0.42	C4/0	14:21	1.1	7.8	18	929	1.7	79																	
9/16/96	1	13	98	76	32.1	0.42	C4/0	16:36	1.9																						
9/16/96	1	13	98	76	32.1	0.42	C5/0	08:57	1.0	8.0	13	870	2.0	75		BQL	1.6	BQL	1.6	2.77	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C5/0	11:10	0.8																						
9/16/96	1	13	98	76	32.1	0.42	C5/0	14:42	1.1	7.9	20	834	1.7	79																	
9/16/96	1	13	98	76	32.1	0.42	C5/0	16:42	2.1																						
9/16/96	1	13	98	76	32.1	0.42	C6/0	09:25	1.0	8.1	13	939	2.0	75		BQL	0.4	BQL	0.4	2.96	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C6/0	11:15	1.2							BQL	0.6	BQL	0.6	2.47	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C6/0	15:35	1.2	8.0	17	934	1.7	79		BQL	0.6	BQL	0.6	2.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	C6/0	16:49	1.7							0.4	0.9	BQL	1.3	2.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	GAC3	09:33	0.0	8.2	16	311				BQL	BQL	BQL	BQL	2.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	GAC1									BQL	BQL	BQL	BQL	2.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/16/96	1	13	98	76	32.1	0.42	GAC2									BQL	BQL	BQL	1.2	2.28	1.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	INF1	08:19		6.9	13	312				475	402	29.7	1040	1.93	BQL	10.7	BQL	112	BQL	BQL	BQL	BQL	4.2	BQL	7

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/17/96	1	13	98	79	30.4	0.38	INFI									544	437	34.4	1190	2.07	BQL	13	BQL	143	BQL	BQL	BQL	BQL	9.9	BQL	8.1
9/17/96	1	13	98	79	30.4	0.38	INFI	13:06		7.0	15	318				508	419	33.5	1110	1.94	BQL	11.7	BQL	125	BQL	BQL	BQL	BQL	8.9	BQL	6.9
9/17/96	1	13	98	79	30.4	0.38	INFI									692	540	43	1470	2.03	BQL	14.2	BQL	166	BQL	BQL	BQL	BQL	6.7	BQL	9.2
9/17/96	1	13	98	79	30.4	0.38	C1/0	08:26	0.2	7.1	14	567	1.8	77	24.7	65.6	114	7.7	192	2.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.2	BQL	0.4
9/17/96	1	13	98	79	30.4	0.38	C1/0	10:40	0.0																						
9/17/96	1	13	98	79	30.4	0.38	C1/0	13:11	0.0	7.2	16	243	1.6	79	23.6																
9/17/96	1	13	98	79	30.4	0.38	C1/0	15:26	0.0	7.2	17	257																			
9/17/96	1	13	98	79	30.4	0.38	C2/0	08:43	0.1	7.3	14	254	1.5	81	25.1	9.5	37.8	1.4	50.6	2.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.9	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C2/0	10:52	0.2																						
9/17/96	1	13	98	79	30.4	0.38	C2/0	13:19	0.0	7.4	16	252	1.5	81	25.1																
9/17/96	1	13	98	79	30.4	0.38	C2/0	15:35	0.0																						
9/17/96	1	13	98	79	30.4	0.38	C3/0	08:54	0.1	7.5	14	266	1.6	79	20.0	1.5	12.6	BQL	14.1	2.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C3/0	10:55	0.4																						
9/17/96	1	13	98	79	30.4	0.38	C3/0	13:26	0.1	7.6	17	528	1.5	81	25.5																
9/17/96	1	13	98	79	30.4	0.38	C3/0	15:40	0.1																						
9/17/96	1	13	98	79	30.4	0.38	C4/0	09:08	0.1	7.7	14	481	1.6	79	22.6	0.2	4.3	BQL	4.5	2.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C4/0	10:58	0.8																						
9/17/96	1	13	98	79	30.4	0.38	C4/0	13:42	0.1	7.8	18	302	1.6	79	20.4																
9/17/96	1	13	98	79	30.4	0.38	C4/0	15:44	0.0																						
9/17/96	1	13	98	79	30.4	0.38	C5/0	09:18	0.5	7.8	14	877	1.8	77	21.1	0.2	1.5	BQL	1.7	2.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C5/0	11:01	0.2																						
9/17/96	1	13	98	79	30.4	0.38	C5/0	14:03	0.0	8.0	17	211	1.5	81	28.0																
9/17/96	1	13	98	79	30.4	0.38	C5/0	15:51	0.1																						
9/17/96	1	13	98	79	30.4	0.38	C6/0	09:29	0.1	8.0	14	790	1.6	79	24.4	BQL	0.5	BQL	0.5	2.66	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C6/0	11:05	0.3							BQL	0.4	BQL	0.4	2.72	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C6/0	14:10	0.0	8.1	17	214	1.5	81	24.4	BQL	0.5	BQL	0.5	2.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/17/96	1	13	98	79	30.4	0.38	C6/0	15:57	0.0																						
9/17/96	1	13	98	79	30.4	0.38	GAC3	09:45	0.0	7.9	17	369				BQL	BQL	BQL	BQL	3.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	INFI	06:50		7.0	13	299				409	380	32.5	BQL	1.65	BQL	11.3	BQL	112	BQL	BQL	BQL	BQL	6.7	BQL	7
9/18/96	1	13	98	79	38.2	0.48	INFI									507	421	35.5	BQL	1.98	BQL	12.5	BQL	133	BQL	BQL	BQL	BQL	5.2	BQL	7.1
9/18/96	1	13	98	79	38.2	0.48	INFI	09:19		7.0	14	420				565	487	33.3	BQL	1.84	BQL	11.7	BQL	126	BQL	BQL	BQL	BQL	4.6	BQL	7.1
9/18/96	1	13	98	79	38.2	0.48	INFI									292	250	26	BQL	2.02	1	8.6	BQL	73	BQL	BQL	BQL	BQL	6.5	BQL	6
9/18/96	1	13	98	79	38.2	0.48	C1/0	06:59	0.3	7.2	13	547	1.7	78	22.5	53.8	99.4	7.8	BQL	2.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4	BQL	0.3
9/18/96	1	13	98	79	38.2	0.48	C1/0	08:45	0.3																						
9/18/96	1	13	98	79	38.2	0.48	C1/0	09:30	0.3	7.2	15	587	1.6	79	22.9																
9/18/96	1	13	98	79	38.2	0.48	C1/0	11:15	0.5																						
9/18/96	1	13	98	79	38.2	0.48	C2/0	07:20	0.2	7.3	13	547	1.6	79	23.8	8.9	38.2	1.4	BQL	2.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C2/0	08:49	0.4																						
9/18/96	1	13	98	79	38.2	0.48	C2/0	09:50	0.4	7.4	16	784	1.7	78	23.8																
9/18/96	1	13	98	79	38.2	0.48	C2/0	11:17	0.5																						
9/18/96	1	13	98	79	38.2	0.48	C3/0	07:28	0.0	7.6	13	226	1.5	81	27.3	1.4	13	0.3	BQL	2.35	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C3/0	08:53	0.3																						
9/18/96	1	13	98	79	38.2	0.48	C3/0	10:11	0.1	7.6	17	395	1.5	81	23.8																
9/18/96	1	13	98	79	38.2	0.48	C3/0	11:19	0.1																						
9/18/96	1	13	98	79	38.2	0.48	C4/0	07:43	0.3	7.8	13	671	1.6	79	25.5	0.2	3.4	BQL	BQL	2.44	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C4/0	08:56	0.4																						
9/18/96	1	13	98	79	38.2	0.48	C4/0	10:43	0.2	7.7	15	874	1.6	79	25.1																
9/18/96	1	13	98	79	38.2	0.48	C4/0	11:23	0.4																						
9/18/96	1	13	98	79	38.2	0.48	C5/0	07:59	0.1	8.0	14	533	1.5	81	28.1	BQL	1.2	BQL	BQL	2.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C5/0	09:01	0.5																						
9/18/96	1	13	98	79	38.2	0.48	C5/0	10:51	0.0	7.9	18	356	1.6	79	19.5																
9/18/96	1	13	98	79	38.2	0.48	C5/0	11:23	0.1																						
9/18/96	1	13	98	79	38.2	0.48	C6/0	08:14	0.3	8.1	14	848	1.6	79	23.8	BQL	0.5	BQL	BQL	2.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C6/0	09:05	0.5							BQL	0.4	BQL	BQL	2.61	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C6/0	11:09	0.3	8.0	17	816	1.7	78	22.9	BQL	0.4	BQL	BQL	2.47	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/18/96	1	13	98	79	38.2	0.48	C6/0	11:24	0.4							BQL	0.4	BQL	BQL	2.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 1

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/18/96	1	13	98	79	38.2	0.48	GAC3	08:26	0.0	8.0	15	476				BQL	BQL	BQL	BQL	2.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	INFI	08:25		7.2	13	286				501	419	38.4	1130	1.93	BQL	12	BQL	141	BQL	BQL	BQL	BQL	12.9	BQL	8.1
9/23/96	1	13	98	72	28.8	0.40	INFI									366	315	27.1	823	1.92	1.4	8.7	BQL	95.7	BQL	BQL	BQL	BQL	3.1	BQL	6.2
9/23/96	1	13	98	72	28.8	0.40	INFI	14:57		7.1	16	415				443	375	33.3	999	2	BQL	11.4	BQL	123	BQL	BQL	BQL	BQL	5.9	BQL	7.1
9/23/96	1	13	98	72	28.8	0.40	INFI									465	425	36.1	1080	2.04	BQL	11.9	BQL	129	BQL	BQL	BQL	BQL	7.3	BQL	7.7
9/23/96	1	13	98	72	28.8	0.40	C1/0	10:30	1.7	7.2	15	932	2.5	70	27.3	83.1	147	9.9	246	2.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.3	BQL	0.6
9/23/96	1	13	98	72	28.8	0.40	C1/0	12:11	1.1	7.3	16																				
9/23/96	1	13	98	72	28.8	0.40	C1/0	14:46	0.8	7.4	17	899	2.0	75	28.3																
9/23/96	1	13	98	72	28.8	0.40	C1/0	16:07	0.6	7.5	17																				
9/23/96	1	13	98	72	28.8	0.40	C2/0	10:10	1.4	7.5	15	931	2.7	67	28.3	16.5	59.6	2.2	81.2	2.54	BQL	BQL	BQL	0.4	BQL	BQL	BQL	BQL	2.5	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C2/0	11:53	1.0	7.5	16																				
9/23/96	1	13	98	72	28.8	0.40	C2/0	14:35	1.1	7.5	18	917	2.2	73	29.3																
9/23/96	1	13	98	72	28.8	0.40	C2/0	15:52	1.0	7.7	17																				
9/23/96	1	13	98	72	28.8	0.40	C3/0	09:57	1.0	7.7	15	936	2.3	72	28.8	1.9	17.6	BQL	20.7	2.71	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.2	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C3/0	11:24	1.4	7.7	16																				
9/23/96	1	13	98	72	28.8	0.40	C3/0	14:21	1.5	7.8	18	904	2.4	71	28.3																
9/23/96	1	13	98	72	28.8	0.40	C3/0	15:41	1.8	7.9	18																				
9/23/96	1	13	98	72	28.8	0.40	C4/0	09:45	1.0	7.8	16	943	2.5	70	29.3	0.4	7.9	BQL	9	1.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C4/0	11:15	2.2	7.9	16																				
9/23/96	1	13	98	72	28.8	0.40	C4/0	14:14	1.2	8.0	18	917	2.3	72	29.3																
9/23/96	1	13	98	72	28.8	0.40	C4/0	15:32	1.3	8.0	18																				
9/23/96	1	13	98	72	28.8	0.40	C5/0	09:10	0.8	8.1	17	900	2.3	72	29.3	BQL	2.6	BQL	3	2.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C5/0	11:05	1.6	8.1	16																				
9/23/96	1	13	98	72	28.8	0.40	C5/0	13:52	0.8	8.2	18	881	2.2	73	27.8																
9/23/96	1	13	98	72	28.8	0.40	C5/0	15:22	2.0	8.3	18																				
9/23/96	1	13	98	72	28.8	0.40	C6/0	08:57	0.6	8.2	16	890	2.3	72	27.3	BQL	1	BQL	1	2.89	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C6/0	10:54	1.0	8.2	16					BQL	1	0.7	1.7	2.62	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C6/0	13:46	0.9	8.2	18	908	2.2	73	29.3	BQL	0.9	BQL	0.9	2.72	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	C6/0	15:12	1.0	8.3	18					BQL	0.9	BQL	0.9	2.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	GAC3	08:41	0.0	7.4	17	273				BQL	BQL	BQL	BQL	3.42	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	GAC1									BQL	BQL	BQL	BQL	2.93	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/23/96	1	13	98	72	28.8	0.40	GAC2									BQL	BQL	BQL	BQL	3.16	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	INFI	08:28		6.9	13	273				415	362	33.3	960	1.79	BQL	12	BQL	125	BQL	BQL	BQL	BQL	6.1	BQL	6.9
9/24/96	1	13	98	79	24.0	0.30	INFI									551	474	38.5	1230	1.99	BQL	12.5	BQL	140	BQL	BQL	BQL	BQL	8.2	BQL	7.9
9/24/96	1	13	98	79	24.0	0.30	INFI	13:09		7.1	15	309				468	402	32.9	1040	1.77	BQL	11.6	BQL	118	BQL	BQL	BQL	BQL	6.6	BQL	6.3
9/24/96	1	13	98	79	24.0	0.30	INFI									531	460	36	1190	1.68	BQL	13	BQL	134	BQL	BQL	BQL	BQL	10.7	BQL	7.9
9/24/96	1	13	98	79	24.0	0.30	C1/0	09:44	0.0	7.0	13	262	1.6	80	23.6	71.1	135	8.2	220	2.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.8	BQL	0.5
9/24/96	1	13	98	79	24.0	0.30	C1/0	11:30	0.0	6.9																					
9/24/96	1	13	98	79	24.0	0.30	C1/0	14:42	0.0	7.3	16	280	1.7	79	24.8																
9/24/96	1	13	98	79	24.0	0.30	C1/0	16:44	0.0	7.3																					
9/24/96	1	13	98	79	24.0	0.30	C2/0	09:36	0.0	7.2	13	254	1.7	79	24.4	9	36.6	1.4	48.8	2.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C2/0	11:11	0.1	7.2																					
9/24/96	1	13	98	79	24.0	0.30	C2/0	14:36	0.3	7.5	16	845	1.7	79	24.0																
9/24/96	1	13	98	79	24.0	0.30	C2/0	16:30	0.3	7.4																					
9/24/96	1	13	98	79	24.0	0.30	C3/0	09:25	0.0	7.4	13	250	1.6	80	24.4	1	10.2	BQL	12	2.6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C3/0	10:57	0.0	7.4																					
9/24/96	1	13	98	79	24.0	0.30	C3/0	13:55	0.2	7.7	20	570	1.6	80	24.0																
9/24/96	1	13	98	79	24.0	0.30	C3/0	16:15	0.6	7.7																					
9/24/96	1	13	98	79	24.0	0.30	C4/0	09:13	0.5	7.6	12	900	1.8	77	24.4	0.2	3.4	BQL	4.1	2.9	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C4/0	10:42	0.3	7.6																					
9/24/96	1	13	98	79	24.0	0.30	C4/0	13:44	0.4	7.8	17	901	1.8	77	22.4																
9/24/96	1	13	98	79	24.0	0.30	C4/0	16:01	0.5	7.9																					
9/24/96	1	13	98	79	24.0	0.30	C5/0	09:01	0.0	7.8	12	225	1.6	80	24.0	BQL	0.9	BQL	0.9	2.88	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C5/0	10:30	0.0	7.7																					
9/24/96	1	13	98	79	24.0	0.30	C5/0	13:26	0.0	8.0	16	300	1.6	80	20.3																
9/24/96	1	13	98	79	24.0	0.30	C5/0	15:52	0.0	8.1																					

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/24/96	1	13	98	79	24.0	0.30	C6/0	08:55	0.0	7.8	11	212	1.6	80	24.4	BQL	0.8	BQL	0.8	2.87	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C6/0	10:18	0.1	7.8						BQL	0.5	BQL	0.5	3.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C6/0	13:12	0.0	8.1	15	220	1.6	80	23.6	BQL	0.3	BQL	0.3	3.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	C6/0	15:41		8.2						BQL	0.3	BQL	0.3	3.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/24/96	1	13	98	79	24.0	0.30	GAC3	08:39	0.0	7.8	11	228				BQL	BQL	BQL	BQL		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	INFI	10:06		7.0	15	334				371	355	29.5	884	1.95	BQL	8.8	BQL	108	BQL	BQL	BQL	BQL	6.1	BQL	5.1
9/25/96	1	13	98	80	23.6	0.29	INFI									466	418	34.1	1060	1.69	BQL	10.9	BQL	118	BQL	BQL	BQL	BQL	6.9	BQL	6.9
9/25/96	1	13	98	80	23.6	0.29	INFI	16:59		7.0	14	286				411	384	32.9	961	1.91	BQL	9.7	BQL	113	BQL	BQL	BQL	BQL	4.8	BQL	5.8
9/25/96	1	13	98	80	23.6	0.29	INFI									416	379	35.2	968	1.64	BQL	10.9	BQL	116	BQL	BQL	BQL	BQL	4.5	BQL	6
9/25/96	1	13	98	80	23.6	0.29	C1/0	09:55	0.0	7.2	16	283	1.6	80	26.4	44.2	85.4	8.4	142	2.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.2	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C1/0	11:59	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C1/0	16:55	0.0	7.2	14	273	1.7	79	24.4																
9/25/96	1	13	98	80	23.6	0.29	C1/0	17:53	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C2/0	09:29	0.2	7.4	17	576	1.7	79	24.8	10.5	41.5	1.7	55.6	2.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.9	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C2/0	11:52	0.3																						
9/25/96	1	13	98	80	23.6	0.29	C2/0	16:46	0.0	7.5	15	265	1.6	80	24.0																
9/25/96	1	13	98	80	23.6	0.29	C2/0	17:29	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C3/0	09:20	0.7	7.6	14	919	1.7	79	24.4	2.1	17	0.9	21	2.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C3/0	11:47	0.6																						
9/25/96	1	13	98	80	23.6	0.29	C3/0	16:42	0.0	7.7	15	247	1.5	81	24.4																
9/25/96	1	13	98	80	23.6	0.29	C3/0	17:26	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C4/0	09:06	0.8	7.8	14	920	1.8	77	24.0	0.2	4.4	BQL	4.6	2.65	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C4/0	11:47	0.7																						
9/25/96	1	13	98	80	23.6	0.29	C4/0	16:42	0.0	7.9	13	235	1.6	80	19.5																
9/25/96	1	13	98	80	23.6	0.29	C4/0	17:26	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C5/0	08:55	0.0	8.0	14	224	1.6	80	24.0	BQL	1.8	BQL	1.8	2.81	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C5/0	11:35	0.1																						
9/25/96	1	13	98	80	23.6	0.29	C5/0	16:24	0.0	8.1	15	220	1.6	80	18.3																
9/25/96	1	13	98	80	23.6	0.29	C5/0	17:17	0.0																						
9/25/96	1	13	98	80	23.6	0.29	C6/0	08:37	0.0	8.0	13	316	1.7	79	24.4	BQL	0.6	BQL	0.6	2.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C6/0	11:22	0.2							BQL	0.4	BQL	0.4	3.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C6/0	16:22	0.0	8.2	16	215	1.6	80	24.0	BQL	0.3	BQL	0.3	3.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	C6/0	17:07	0.0							BQL	0.4	BQL	0.4	3.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/25/96	1	13	98	80	23.6	0.29	GAC3	08:23	0.0	8.0	13	240				BQL	BQL	BQL	BQL	3.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	INFI	10:22		7.0	13	429				368	344	25.3	BQL	1.75	BQL	8.5	BQL	92.7	BQL	BQL	BQL	BQL	5.1	BQL	4.5
9/26/96	1	13	108	77	25.2	0.33	INFI									358	336	28.2	BQL	1.68	BQL	8.8	BQL	97.6	BQL	BQL	BQL	BQL	7.1	BQL	5
9/26/96	1	13	108	77	25.2	0.33	INFI	14:32		7.1	17	396				517	485	35.9	BQL	1.71	BQL	11.2	BQL	122	BQL	BQL	BQL	BQL	5.7	BQL	6.3
9/26/96	1	13	108	77	25.2	0.33	INFI									343	325	29.5	BQL	1.8	1.1	9.7	BQL	75	BQL	BQL	BQL	BQL	3.5	BQL	5.1
9/26/96	1	13	108	77	25.2	0.33	C1/0	10:10	1.1	7.3	13	958	2.6	78	26.0	88.8	164	10.3	BQL	1.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5	BQL	0.4
9/26/96	1	13	108	77	25.2	0.33	C1/0	11:36	1.7																						
9/26/96	1	13	108	77	25.2	0.33	C1/0	14:23	1.5	7.3	15	989	2.7	77	26.4																
9/26/96	1	13	108	77	25.2	0.33	C1/0	16:09	2.1																						
9/26/96	1	13	108	77	25.2	0.33	C2/0	09:54	1.3	7.5	13	951	2.8	76	24.0	11.4	49.2	1.5	BQL	2.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C2/0	11:31	3.0																						
9/26/96	1	13	108	77	25.2	0.33	C2/0	14:14	2.4	7.5	16	988	3.0	74	24.8																
9/26/96	1	13	108	77	25.2	0.33	C2/0	16:03	3.1																						
9/26/96	1	13	108	77	25.2	0.33	C3/0	09:35	1.0	7.6	13	882	2.6	78	22.4	1.8	18.8	0.3	BQL	2.88	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C3/0	11:20	1.7																						
9/26/96	1	13	108	77	25.2	0.33	C3/0	14:03	1.7	7.6	16	951	2.8	76	26.8																
9/26/96	1	13	108	77	25.2	0.33	C3/0	15:58	2.6																						
9/26/96	1	13	108	77	25.2	0.33	C4/0	09:18	2.9	7.9	12	925	2.7	77	24.4	0.3	7.9	BQL	BQL	2.59	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C4/0	11:15	1.7																						
9/26/96	1	13	108	77	25.2	0.33	C4/0	13:55	1.9	7.9	15	972	2.9	75	25.6																
9/26/96	1	13	108	77	25.2	0.33	C4/0	15:54	2.4																						
9/26/96	1	13	108	77	25.2	0.33	C5/0	09:09	3.1	8.0	12	968	2.6	78	21.9	BQL	2.9	BQL	BQL	3.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C5/0	11:08	1.1																						

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/26/96	1	13	108	77	25.2	0.33	C5/0	13:35	1.9	8.1	16	873	3.1	72	26.8																
9/26/96	1	13	108	77	25.2	0.33	C5/0	15:46	3.9																						
9/26/96	1	13	108	77	25.2	0.33	C6/0	08:49	0.4	8.1	12	791	2.6	78	22.8	BQL	1.2	BQL	BQL	3.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C6/0	10:52	2.5							BQL	0.8	BQL	BQL	3.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C6/0	13:26	1.3	8.2	14	942	3.1	72	25.6	BQL	0.8	BQL	BQL	4.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	C6/0	15:40	2.4							BQL	1	BQL	BQL	3.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/26/96	1	13	108	77	25.2	0.33	GAC3	10:44	0.0	8.2	12	338				BQL	BQL	BQL	BQL	3.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	INF1	09:48		6.9	13	414				457	415	28.6	1040	1.69	BQL	12.4	BQL	113	BQL	BQL	BQL	BQL	3.8	BQL	5.6
9/27/96	1	13	108	76	25.2	0.33	INF1									482	446	33.2	1100	1.56	BQL	15.1	BQL	117	BQL	BQL	BQL	BQL	4.1	BQL	6.8
9/27/96	1	13	108	76	25.2	0.33	INF1	15:15		6.9	14	416				475	446	31	1090	1.54	BQL	12.8	BQL	111	BQL	BQL	BQL	BQL	6.5	BQL	6.4
9/27/96	1	13	108	76	25.2	0.33	INF1									381	322	33.9	868	1.72	BQL	10.9	BQL	109	BQL	BQL	BQL	BQL	5.6	BQL	5.8
9/27/96	1	13	108	76	25.2	0.33	C1/0	09:42	1.4	7.1	12	984	2.6	78	25.6	87.8	173	9.7	276	1.95	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.1	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C1/0	11:57	2.1																						
9/27/96	1	13	108	76	25.2	0.33	C1/0	15:09	1.4	7.1	15	975	2.2	83	23.6																
9/27/96	1	13	108	76	25.2	0.33	C1/0	16:21	0.6																						
9/27/96	1	13	108	76	25.2	0.33	C2/0	09:30	2.6	7.3	11	990	2.8	76	26.4	12.6	59.4	1.9	76.2	2.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.3	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C2/0	11:54	2.7																						
9/27/96	1	13	108	76	25.2	0.33	C2/0	14:51	2.4	7.2	15	990	2.1	84	25.2																
9/27/96	1	13	108	76	25.2	0.33	C2/0	16:13	0.5																						
9/27/96	1	13	108	76	25.2	0.33	C3/0	09:18	2.5	7.4	10	985	2.8	76	25.6	1.5	17	0.4	19.8	2.49	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C3/0	11:49	2.8																						
9/27/96	1	13	108	76	25.2	0.33	C3/0	14:28	2.0	7.5	15	987	2.0	85	28.9																
9/27/96	1	13	108	76	25.2	0.33	C3/0	16:09	0.5																						
9/27/96	1	13	108	76	25.2	0.33	C4/0	09:13	2.6	7.5	10	977	2.9	75	26.8	0.3	8.6	BQL	9.5	2.67	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C4/0	11:44	3.3																						
9/27/96	1	13	108	76	25.2	0.33	C4/0	14:39	2.3	7.7	15	977	2.2	83	24.0																
9/27/96	1	13	108	76	25.2	0.33	C4/0	16:04	0.8																						
9/27/96	1	13	108	76	25.2	0.33	C5/0	09:00	3.4	7.8	9	982	2.9	75	25.2	BQL	4.2	BQL	4.2	2.78	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C5/0	11:38	3.9																						
9/27/96	1	13	108	76	25.2	0.33	C5/0	14:39	2.9	7.8	15	967	1.8	87	21.9																
9/27/96	1	13	108	76	25.2	0.33	C5/0	16:04	0.0																						
9/27/96	1	13	108	76	25.2	0.33	C6/0	09:00	2.6	7.8	9	952	3.0	74	25.6	BQL	0.9	BQL	0.9	2.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C6/0	11:38	3.1							BQL	1.1	BQL	1.1	1.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C6/0	14:20	2.3	7.9	15	922	2.1	84	23.6	BQL	1.4	BQL	1.4	2.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	C6/0	16:00	0.6							BQL	1.6	BQL	1.6	1.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/27/96	1	13	108	76	25.2	0.33	GAC3	08:12	0.0	7.9	13	234				BQL	BQL	BQL	BQL	3.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	INF1	09:14		8.0	11	241				391	367	25.9	903	1.46	BQL	9.9	BQL	96.7	BQL	BQL	BQL	BQL	5.9	BQL	6.6
9/28/96	1	13	100	75	35.4	0.47	INF1									413	400	30.5	969	1.39	BQL	10.5	BQL	102	BQL	BQL	BQL	BQL	6.1	BQL	7.3
9/28/96	1	13	100	75	35.4	0.47	INF1	14:40		7.0	17	419				380	376	34.2	922	1.16	BQL	11.6	BQL	105	BQL	BQL	BQL	BQL	9.1	BQL	6.4
9/28/96	1	13	100	75	35.4	0.47	INF1									403	392	36.5	957	1.51	BQL	12.2	BQL	102	BQL	BQL	BQL	BQL	4.7	BQL	6.4
9/28/96	1	13	100	75	35.4	0.47	C1/0	10:37	0.4	7.3	14	862	1.9	78	37.7	116	229	8.8	359	1.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C1/0	12:02	1.0																						
9/28/96	1	13	100	75	35.4	0.47	C1/0	14:36	0.5	7.2	17	924	2.3	74	33.0																
9/28/96	1	13	100	75	35.4	0.47	C1/0	16:09	1.0																						
9/28/96	1	13	100	75	35.4	0.47	C2/0	10:30	0.5	7.4	14	922	2.0	77	36.5	11.4	45.2	1.7	60.3	1.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C2/0	12:00	1.5																						
9/28/96	1	13	100	75	35.4	0.47	C2/0	14:21	0.7	7.5	17	937	2.3	74	33.6																
9/28/96	1	13	100	75	35.4	0.47	C2/0	16:02	1.5																						
9/28/96	1	13	100	75	35.4	0.47	C3/0	10:10	1.0	7.5	13	951	2.0	77	36.5	1.7	18.5	BQL	21.3	2.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C3/0	11:53	1.2																						
9/28/96	1	13	100	75	35.4	0.47	C3/0	14:05	0.8	7.7	17	947	2.6	70	25.9																
9/28/96	1	13	100	75	35.4	0.47	C3/0	15:52	1.1																						
9/28/96	1	13	100	75	35.4	0.47	C4/0	09:41	0.9	7.8	13	921	2.2	75	36.0	0.3	7.3	BQL	8.1	2.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C4/0	11:38	1.5																						
9/28/96	1	13	100	75	35.4	0.47	C4/0	13:52	1.5	7.9	17	955	2.3	74	31.8																
9/28/96	1	13	100	75	35.4	0.47	C4/0	15:57	0.6																						

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 1

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/28/96	1	13	100	75	35.4	0.47	C5/0	09:58	1.5	8.0	13	952	2.2	75	37.7	BQL	2.4	BQL	2.4	2.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C5/0	11:50	0.1																						
9/28/96	1	13	100	75	35.4	0.47	C5/0	13:54	1.5	7.9	17	950	2.3	74	33.0																
9/28/96	1	13	100	75	35.4	0.47	C5/0	15:52	1.0																						
9/28/96	1	13	100	75	35.4	0.47	C6/0	09:41	0.7	8.1	11	886	2.2	75	34.8	BQL	0.4	BQL	0.4	2.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C6/0	11:38	0.9							BQL	0.6	BQL	0.6	2.16	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C6/0	13:52	1.0	8.0	16	913	2.2	75	35.4	BQL	0.9	BQL	0.9	2.58	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	C6/0	15:57	0.7							BQL	0.9	BQL	0.9	2.49	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	GAC3	09:00	0.3	7.8	19	320				BQL	BQL	BQL	BQL	2.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	GAC1									BQL	BQL	BQL	BQL	2.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/28/96	1	13	100	75	35.4	0.47	GAC2									BQL	BQL	BQL	BQL	2.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	INFI	09:48		6.8	14	427				374	359	32.5	885	1.4	BQL	11.1	BQL	94.1	BQL	BQL	BQL	BQL	8.5	BQL	6.1
9/29/96	1	13	100	75	36.6	0.49	INFI									414	391	31.5	951	1.4	BQL	10.6	BQL	91.3	BQL	BQL	BQL	BQL	6.9	BQL	5.8
9/29/96	1	13	100	75	36.6	0.49	INFI	14:36		6.7	17	415				394	358	32.8	908	1.38	BQL	10.4	BQL	100	BQL	BQL	BQL	BQL	6.7	BQL	5.6
9/29/96	1	13	100	75	36.6	0.49	INFI									394	376	29.7	916	1.56	BQL	9.5	BQL	95.6	BQL	BQL	BQL	BQL	5.7	BQL	5.2
9/29/96	1	13	100	75	36.6	0.49	INFI									469	462	38.5	1100	1.4	BQL	11.4	BQL	109	BQL	BQL	BQL	BQL	6.4	BQL	6
9/29/96	1	13	100	75	36.6	0.49	C1/0	09:42	0.4	7.0	13	898	2.0	77	36.0	74.2	150	8.3	238	1.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.7	BQL	0.4
9/29/96	1	13	100	75	36.6	0.49	C1/0	10:43	0.6																						
9/29/96	1	13	100	75	36.6	0.49	C1/0	14:29	0.9	6.9	17	963	1.9	78	36.6																
9/29/96	1	13	100	75	36.6	0.49	C1/0	16:54	0.1																						
9/29/96	1	13	100	75	36.6	0.49	C2/0	09:30	0.6	7.3	13	952	2.1	76	40.2	14.6	67.5	2	86.3	2.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.2	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C2/0	10:38	0.7																						
9/29/96	1	13	100	75	36.6	0.49	C2/0	14:16	0.6	7.2	17	952	1.9	78	48.8																
9/29/96	1	13	100	75	36.6	0.49	C2/0	16:43	0.0																						
9/29/96	1	13	100	75	36.6	0.49	C3/0	09:26	0.7	7.4	13	947	2.0	77	38.4	2.3	21.3	0.4	25	2.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C3/0	10:33	0.6																						
9/29/96	1	13	100	75	36.6	0.49	C3/0	14:02	1.5	7.5	18	948	2.0	77	38.4																
9/29/96	1	13	100	75	36.6	0.49	C3/0	16:40	0.3																						
9/29/96	1	13	100	75	36.6	0.49	C4/0	09:14	0.5	7.6	14	914	2.1	76	39.0	0.3	6.9	BQL	7.8	2.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C4/0	10:28	0.6																						
9/29/96	1	13	100	75	36.6	0.49	C4/0	13:54	0.4	7.6	17	933	2.1	76	38.4																
9/29/96	1	13	100	75	36.6	0.49	C4/0	16:37	0.4																						
9/29/96	1	13	100	75	36.6	0.49	C5/0	09:06	0.6	7.8	13	927	2.2	75	36.0	BQL	2	BQL	2	2.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C5/0	10:20	1.3																						
9/29/96	1	13	100	75	36.6	0.49	C5/0	13:38	1.3	7.7	17	948	2.5	71	33.5																
9/29/96	1	13	100	75	36.6	0.49	C5/0	16:32	1.4																						
9/29/96	1	13	100	75	36.6	0.49	C6/0	08:55	0.5	8.0	13	883	2.1	76	40.8	BQL	0.4	BQL	0.4	2.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C6/0	10:14	0.6							BQL	0.5	BQL	0.5	2.03	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C6/0	13:26	0.6	7.8	16	902	2.2	75	36.6	BQL	0.6	BQL	0.6	2.47	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/29/96	1	13	100	75	36.6	0.49	C6/0	16:29	0.7																						
9/29/96	1	13	100	75	36.6	0.49	GAC3	08:20	0.0	7.8	12	238				BQL	BQL	BQL	BQL	3.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	INFI	10:37		6.9	16	320				429	437	28.6	1020	1.37	BQL	BQL	11.6	101	BQL	BQL	BQL	BQL	5.9	BQL	6.4
9/30/96	1	13	100	76	36.6	0.48	INFI									521	521	35	1230	1.41	BQL	13.7	BQL	124	BQL	BQL	BQL	BQL	7.4	BQL	8.5
9/30/96	1	13	100	76	36.6	0.48	INFI	15:00		6.9	18	421				449	418	31.4	1030	1.45	BQL	11.8	BQL	107	BQL	BQL	BQL	BQL	6.3	BQL	6.7
9/30/96	1	13	100	76	36.6	0.48	INFI									432	448	33.6	1040	1.36	BQL	11.3	BQL	106	BQL	BQL	BQL	BQL	5.4	BQL	6.7
9/30/96	1	13	100	76	36.6	0.48	INFI									486	480	35.4	1140	1.49	BQL	12.3	BQL	108	BQL	BQL	BQL	BQL	6.7	BQL	7.1
9/30/96	1	13	100	76	36.6	0.48	C1/0	10:16	0.0	7.1	15	289	1.8	79	38.4	84.2	168	9.6	267	1.74	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.2	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C1/0	11:44	0.6																						
9/30/96	1	13	100	76	36.6	0.48	C1/0	14:36	0.3	7.1	21	595	2.0	77	38.4																
9/30/96	1	13	100	76	36.6	0.48	C1/0	16:53	0.4																						
9/30/96	1	13	100	76	36.6	0.48	C2/0	09:50	0.0	7.3	16	304	1.8	79	36.6	9.1	47.5	1.4	59.8	1.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C2/0	11:42	0.9																						
9/30/96	1	13	100	76	36.6	0.48	C2/0	14:24	0.2	7.3	20	558	2.1	76	42.7																
9/30/96	1	13	100	76	36.6	0.48	C2/0	16:50	0.6																						
9/30/96	1	13	100	76	36.6	0.48	C3/0	09:29	0.2	7.4	14	873	1.9	78	37.2	1.3	15.2	BQL	17.5	2.38	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C3/0	11:39	0.7																						

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
9/30/96	1	13	100	76	36.6	0.48	C3/0	14:07	0.3	7.5	21	817	2.0	77	39.6																
9/30/96	1	13	100	76	36.6	0.48	C3/0	16:46	0.6																						
9/30/96	1	13	100	76	36.6	0.48	C4/0	08:56	0.3	7.7	15	778	1.9	78	37.2	0.2	5.9	BQL	6.6	2.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C4/0	11:36	1.3																						
9/30/96	1	13	100	76	36.6	0.48	C4/0	13:58	0.5	7.7	21	916	2.4	72	30.5																
9/30/96	1	13	100	76	36.6	0.48	C4/0	16:43	0.5																						
9/30/96	1	13	100	76	36.6	0.48	C5/0	08:48	0.9	7.9	14	930	2.2	75	33.5	BQL	2.9	BQL	2.9	2.6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C5/0	11:32	1.1																						
9/30/96	1	13	100	76	36.6	0.48	C5/0	13:50	0.6	7.9	21	909	2.5	71	36.6																
9/30/96	1	13	100	76	36.6	0.48	C5/0	16:37	1.4																						
9/30/96	1	13	100	76	36.6	0.48	C6/0	08:40	0.6	8.0	14	887	2.2	75	36.0	BQL	0.5	BQL	0.5	2.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C6/0	11:29	0.5							BQL	0.6	BQL	0.6	2.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C6/0	13:47	0.3	7.9	21	842	2.2	75	36.6	BQL	1.2	BQL	1.2	2.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	C6/0	16:33	0.4							BQL	0.8	BQL	0.8	2.97	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
9/30/96	1	13	100	76	36.6	0.48	GAC3	08:24	0.0	7.9	14	233				BQL	BQL	BQL	BQL	3.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	INF1	10:20		6.7	16	420				114	119	10.4	285	1.42	BQL	4	BQL	33.1	BQL	BQL	BQL	BQL	2.9	BQL	2
10/1/96	1	13	100	77	42.1	0.55	INF1									347	358	23.9	814	1.32	BQL	8.8	BQL	70.6	BQL	BQL	BQL	BQL	5.6	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	INF1	15:30		6.9	20	400				470	480	30.9	1110	1.32	BQL	11.5	BQL	108	BQL	BQL	BQL	BQL	6.9	BQL	6.1
10/1/96	1	13	100	77	42.1	0.55	INF1									348	353	30.7	845	1.38	BQL	8.8	BQL	91.9	BQL	BQL	BQL	BQL	7.9	BQL	4.9
10/1/96	1	13	100	77	42.1	0.55	INF1									423	419	29.4	980	1.43	BQL	9	BQL	88.2	BQL	BQL	BQL	BQL	6.6	BQL	5
10/1/96	1	13	100	77	42.1	0.55	C1/0	09:51	0.1	7.1	18	407	1.7	80	42.1	63.4	135	8	211	1.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.5	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C1/0	11:16	0.3																						
10/1/96	1	13	100	77	42.1	0.55	C1/0	15:25	0.6	7.1	18	932	2.1	76	42.7																
10/1/96	1	13	100	77	42.1	0.55	C1/0	16:37	0.0																						
10/1/96	1	13	100	77	42.1	0.55	C2/0	09:45	0.3	7.4	15	887	2.0	77	42.7	9.7	45.1	1.4	57.9	2.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C2/0	11:12	0.3																						
10/1/96	1	13	100	77	42.1	0.55	C2/0	15:17	0.4	7.3	20	919	2.2	75	38.4																
10/1/96	1	13	100	77	42.1	0.55	C2/0	16:34	0.1																						
10/1/96	1	13	100	77	42.1	0.55	C3/0	09:39	0.7	7.6	15	943	1.7	80	54.9	2.3	20.1	0.9	24.5	2.03	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.2	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C3/0	11:08	1.1																						
10/1/96	1	13	100	77	42.1	0.55	C3/0	15:00	0.0	7.6	20	242	1.7	80	36.6																
10/1/96	1	13	100	77	42.1	0.55	C3/0	16:30	0.3																						
10/1/96	1	13	100	77	42.1	0.55	C4/0	09:11	0.1	7.8	17	661	2.0	77	39.6	0.4	6	BQL	7	2.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C4/0	11:04	0.3																						
10/1/96	1	13	100	77	42.1	0.55	C4/0	14:58	0.0	7.4	20	263	1.9	78	42.7																
10/1/96	1	13	100	77	42.1	0.55	C4/0	16:25	0.1																						
10/1/96	1	13	100	77	42.1	0.55	C5/0	09:05	0.4	7.9	15	889	2.1	76	37.8	BQL	2.3	BQL	2.3	2.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C5/0	10:59	0.8																						
10/1/96	1	13	100	77	42.1	0.55	C5/0	03:07	0.7	7.9	20	913	2.3	74	39.0																
10/1/96	1	13	100	77	42.1	0.55	C5/0	16:22	0.8																						
10/1/96	1	13	100	77	42.1	0.55	C6/0	08:44	0.2	8.0	16	703	1.9	78	41.5	BQL	0.4	BQL	0.4	2.01	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C6/0	10:52	0.2							BQL	0.6	BQL	0.6	2.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C6/0	14:41	0.5	8.0	21	897	2.3	74	38.4	BQL	0.8	BQL	0.8	2.62	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	C6/0	16:16	0.4							BQL	1	BQL	1	2.67	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	GAC3	08:28	0.0	7.9	15	235				BQL	BQL	BQL	BQL	2.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	GAC1									0.4	0.4	BQL	0.8	2.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/1/96	1	13	100	77	42.1	0.55	GAC2									1.4	1.4	BQL	3.1	2.52	BQL	BQL	BQL	0.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	INF1	08:03		7.1	13	311				456	442	35.9	1060	2.36	BQL	11.3	BQL	99.8	BQL	BQL	BQL	BQL	6	BQL	5.7
10/2/96	1	13	100	78	45.7	0.59	INF1									448	426	35.1	1030	2.14	BQL	10.5	BQL	100	BQL	BQL	BQL	BQL	5.6	BQL	6
10/2/96	1	13	100	78	45.7	0.59	INF1	11:10		7.1	13	295				403	388	31.6	923	1.81	BQL	9.5	BQL	80.7	BQL	BQL	BQL	BQL	5	BQL	5.1
10/2/96	1	13	100	78	45.7	0.59	INF1									396	386	29.1	911	2.33	BQL	8.9	BQL	79.3	BQL	BQL	BQL	BQL	6.7	BQL	4.7
10/2/96	1	13	100	78	45.7	0.59	INF1									474	475	31.6	1080	2.48	BQL	9.9	BQL	80.7	BQL	BQL	BQL	BQL	5.7	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C1/0	07:57	0.0	7.3	12	282	1.7	80	57.9	53.5	99.8	7.3	165	3.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C1/0	08:54	0.0																						
10/2/96	1	13	100	78	45.7	0.59	C1/0	10:46	0.0	7.2	14	280			0.0																
10/2/96	1	13	100	78	45.7	0.59	C2/0	07:16	0.0	7.5	14	290	1.9	78	43.9	8	40.1	1.5	51.3	3.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/2/96	1	13	100	78	45.7	0.59	C2/0	08:41	0.0																						
10/2/96	1	13	100	78	45.7	0.59	C2/0	10:28	0.0	7.4	16	281			0.0																
10/2/96	1	13	100	78	45.7	0.59	C3/0	07:07	0.1	7.7	15	292	1.8	79	43.9	1.1	10.6	BQL	12.5	3.98	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C3/0	08:35	0.1																						
10/2/96	1	13	100	78	45.7	0.59	C3/0	10:00	0.0	7.6	17	354			0.0																
10/2/96	1	13	100	78	45.7	0.59	C4/0	07:02	0.1	7.8	14	516	1.8	79	48.8	0.3	3.2	BQL	3.9	4.38	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C4/0	08:32	0.1																						
10/2/96	1	13	100	78	45.7	0.59	C4/0	09:35	0.1	7.8	15	539			0.0																
10/2/96	1	13	100	78	45.7	0.59	C5/0	06:38	0.1	8.0	14	524	2.1	76	35.4	BQL	1	BQL	1	4.39	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C5/0	08:28	0.4																						
10/2/96	1	13	100	78	45.7	0.59	C5/0	09:28	0.5	8.0	12	925			0.0																
10/2/96	1	13	100	78	45.7	0.59	C6/0	06:34	0.2	8.1	13	773	1.9	78	42.7	BQL	0.5	BQL	0.5	5.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C6/0	08:22	0.3							BQL	0.4	BQL	0.4	4.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C6/0	09:15	0.2	8.1	14	856			0.0	BQL	0.4	BQL	0.4	5.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	C6/0									BQL	0.4	BQL	0.4	5.49	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	GAC3		0.0	8.1	13	235				0.2	0.2	BQL	0.4		BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/2/96	1	13	100	78	45.7	0.59	GAC1																								
10/2/96	1	13	100	78	45.7	0.59	GAC2																								
10/7/96	1	13	98	74	34.9	0.47	INF1	14:58		6.9	14	432				427	419	35.2	1020	1.34	BQL	11.2	BQL	112	BQL	BQL	BQL	BQL	5.7	BQL	6.4
10/7/96	1	13	98	74	34.9	0.47	INF1									429	408	34.6	1000	1.27	BQL	11.4	BQL	106	BQL	BQL	BQL	BQL	8.5	BQL	5.9
10/7/96	1	13	98	74	34.9	0.47	INF1									585	529	35.9	1280	1.49	BQL	11.8	BQL	110	BQL	BQL	BQL	BQL	6.3	BQL	6.2
10/7/96	1	13	98	74	34.9	0.47	INF1									369	344	31.2	858	1.46	BQL	10.1	BQL	91	BQL	BQL	BQL	BQL	7.5	BQL	5
10/7/96	1	13	98	74	34.9	0.47	C1/0	14:45	0.5	7.1	14	842	1.9	76	33.9	50.2	100	6	160	1.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.4	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C1/0	16:28	0.8																						
10/7/96	1	13	98	74	34.9	0.47	C1/0								0.0																
10/7/96	1	13	98	74	34.9	0.47	C1/0																								
10/7/96	1	13	98	74	34.9	0.47	C2/0	14:37	0.8	7.3	13	901	2.0	75	35.3	7.4	34.7	1.1	44.7	1.85	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.5	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C2/0	16:25	1.3																						
10/7/96	1	13	98	74	34.9	0.47	C2/0								0.0																
10/7/96	1	13	98	74	34.9	0.47	C2/0																								
10/7/96	1	13	98	74	34.9	0.47	C3/0	14:32	1.0	7.5	13	912	2.0	75	33.9	1.1	12.9	0.3	15.1	2.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C3/0	16:21	1.2																						
10/7/96	1	13	98	74	34.9	0.47	C3/0								0.0																
10/7/96	1	13	98	74	34.9	0.47	C3/0																								
10/7/96	1	13	98	74	34.9	0.47	C4/0	14:26	1.2	7.7	13	905	2.0	75	33.9	0.2	4.9	BQL	5.6	2.01	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C4/0	16:16	1.3																						
10/7/96	1	13	98	74	34.9	0.47	C4/0								0.0																
10/7/96	1	13	98	74	34.9	0.47	C4/0																								
10/7/96	1	13	98	74	34.9	0.47	C5/0	14:14	1.3	7.8	14	890	2.1	74	36.0	BQL	1.5	BQL	1.5	2.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C5/0	16:10	1.4																						
10/7/96	1	13	98	74	34.9	0.47	C5/0								0.0																
10/7/96	1	13	98	74	34.9	0.47	C5/0																								
10/7/96	1	13	98	74	34.9	0.47	C6/0	14:02	0.8	8.0	14	842	1.9	76	34.6	BQL	0.9	BQL	0.9	2.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C6/0	16:04	1.2							BQL	0.8	BQL	0.8	2.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C6/0								0.0	BQL	0.5	BQL	0.5	2.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	C6/0									BQL	0.5	BQL	0.5	1.97	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	GAC3	13:47	0.0							BQL	BQL	BQL	BQL	2.35	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/7/96	1	13	98	74	34.9	0.47	GAC1																								
10/7/96	1	13	98	74	34.9	0.47	GAC2																								
10/8/96	1	13	98	77	39.8	0.52	INF1	10:02		6.8	14	427				394	388	27.8	926	1.24	BQL	11	BQL	90.8	BQL	BQL	BQL	BQL	9.1	BQL	5.3
10/8/96	1	13	98	77	39.8	0.52	INF1									393	399	33.8	940	1.08	BQL	11.1	BQL	94.3	BQL	BQL	BQL	BQL	3.3	BQL	5.3
10/8/96	1	13	98	77	39.8	0.52	INF1	15:42		6.7	16	429				385	395	25.1	900	1.33	BQL	9.2	BQL	76.7	BQL	BQL	BQL	BQL	3.6	BQL	5.7
10/8/96	1	13	98	77	39.8	0.52	INF1									395	408	29.4	946	1.34	BQL	10.8	BQL	90.2	BQL	BQL	BQL	BQL	5.5	BQL	7.2
10/8/96	1	13	98	77	39.8	0.52	INF1									380	379	43.9	922	1.36	BQL	14	BQL	85.5	BQL	BQL	BQL	BQL	8.1	BQL	11
10/8/96	1	13	98	77	39.8	0.52	C1/0	09:34	0.4	7.0	14	730	1.9	76	40.5	53.3	120	7.5	186	1.72	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.6	BQL	0.5
10/8/96	1	13	98	77	39.8	0.52	C1/0	11:30	0.4																						

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/8/96	1	13	98	77	39.8	0.52	C1/0	14:58	0.4	7.0	21	593	1.9	76	39.2																
10/8/96	1	13	98	77	39.8	0.52	C1/0	16:44	0.5																						
10/8/96	1	13	98	77	39.8	0.52	C2/0	09:26	0.6	7.2	12	902	2.0	75	39.8	11	43.8	1.6	58.5	1.78	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.1	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C2/0	11:28	0.7																						
10/8/96	1	13	98	77	39.8	0.52	C2/0	14:51	0.6	7.2	17	867	2.0	75	39.2																
10/8/96	1	13	98	77	39.8	0.52	C2/0	16:39	0.6																						
10/8/96	1	13	98	77	39.8	0.52	C3/0	09:04	0.7	7.5	12	852	2.0	75	39.8	1.5	15.9	BQL	18.3	1.88	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C3/0	11:24	0.7																						
10/8/96	1	13	98	77	39.8	0.52	C3/0	14:40	0.6	7.4	18	897	2.0	75	39.8																
10/8/96	1	13	98	77	39.8	0.52	C3/0	16:32	0.6																						
10/8/96	1	13	98	77	39.8	0.52	C4/0	08:58	0.8	7.7	11	903	2.0	75	39.8	0.2	5	BQL	5.8	2.04	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C4/0	11:20	0.7																						
10/8/96	1	13	98	77	39.8	0.52	C4/0	14:25	0.5	7.7	19	825	1.9	76	39.2																
10/8/96	1	13	98	77	39.8	0.52	C4/0	16:27	0.5																						
10/8/96	1	13	98	77	39.8	0.52	C5/0	08:50	0.7	7.8	11	884	2.1	74	38.5	BQL	2.1	BQL	2.1	2.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C5/0	11:16	0.8																						
10/8/96	1	13	98	77	39.8	0.52	C5/0	14:16	0.5	7.7	18	880	2.0	75	37.1																
10/8/96	1	13	98	77	39.8	0.52	C5/0	16:19	0.4																						
10/8/96	1	13	98	77	39.8	0.52	C6/0	08:36	0.5	7.9	11	843	1.9	76	39.8	BQL	BQL	BQL	BQL	2.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C6/0	11:11	0.6							BQL	BQL	BQL	BQL	2.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C6/0	14:03	0.4	7.8	18	809	1.8	77	38.5	BQL	0.7	BQL	0.7	2.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	C6/0	16:14	0.4							BQL	0.6	BQL	0.6	2.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	GAC3	08:22	0.0	7.8	10	279				BQL	BQL	BQL	BQL	3.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	GAC1									BQL	BQL	BQL	BQL	2.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/8/96	1	13	98	77	39.8	0.52	GAC2									BQL	BQL	BQL	BQL	2.95	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	INF1	09:32		6.8	14	434				318	334	32	808	1.2	2.3	11.6	BQL	93.7	BQL	BQL	BQL	BQL	8	BQL	8.9
10/9/96	1	13	98	77	40.1	0.52	INF1									339	340	34.7	811	1.2	2.3	12.2	BQL	70.7	BQL	BQL	BQL	BQL	7.4	BQL	4.8
10/9/96	1	13	98	77	40.1	0.52	INF1	14:22		6.7	16	426				345	356	33.7	857	1.18	1.9	13.1	BQL	93.1	BQL	BQL	BQL	BQL	8.9	BQL	5.6
10/9/96	1	13	98	77	40.1	0.52	INF1									320	335	30.5	795	1.25	1.8	11	BQL	85.8	BQL	BQL	BQL	BQL	5.9	BQL	4.7
10/9/96	1	13	98	77	40.1	0.52	INF1									410	408	33.8	972	1.34	1.6	9.3	BQL	96.4	BQL	BQL	BQL	BQL	6.3	BQL	6.7
10/9/96	1	13	98	77	40.1	0.52	C1/0	09:22	0.5	7.0	13	896	1.9	76	39.7	58.1	127	9.2	199	1.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.6	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C1/0	11:37	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C1/0	14:15	0.4	6.9	16	893	1.6	80	39.0																
10/9/96	1	13	98	77	40.1	0.52	C1/0	16:30	0.5																						
10/9/96	1	13	98	77	40.1	0.52	C2/0	09:16	0.6	7.2	12	918	1.7	79	39.7	9.6	53.2	1.6	66.2	1.73	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C2/0	11:33	0.9																						
10/9/96	1	13	98	77	40.1	0.52	C2/0	14:07	0.5	7.1	17	905	1.7	79	39.0																
10/9/96	1	13	98	77	40.1	0.52	C2/0	16:26	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C3/0	09:10	0.8	7.4	12	922	1.7	79	40.4	1.2	13.7	BQL	15.7	1.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C3/0	11:30	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C3/0	13:45	0.7	7.4	18	855	1.7	79	39.0																
10/9/96	1	13	98	77	40.1	0.52	C3/0	16:23	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C4/0	08:59	0.8	7.5	12	913	1.7	79	40.4	0.3	6.3	BQL	6.6	2.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C4/0	11:25	0.8																						
10/9/96	1	13	98	77	40.1	0.52	C4/0	13:35	0.6	7.6	17	898	1.6	80	39.0																
10/9/96	1	13	98	77	40.1	0.52	C4/0	16:20	0.8																						
10/9/96	1	13	98	77	40.1	0.52	C5/0	08:53	0.6	7.7	12	901	1.7	79	40.4	BQL	1.8	BQL	1.8	2.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C5/0	11:21	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C5/0	13:28	0.6	7.6	17	893	1.7	79	39.0																
10/9/96	1	13	98	77	40.1	0.52	C5/0	16:17	0.7																						
10/9/96	1	13	98	77	40.1	0.52	C6/0	08:40	0.7	7.8	12	868	1.8	77	39.7	BQL	0.5	BQL	0.5	2.13	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C6/0	11:17	0.5							BQL	0.6	BQL	0.6	2.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C6/0	13:19	0.4	7.8	17	865	1.7	79	39.7	BQL	0.7	BQL	0.7	2.15	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	C6/0	16:14	0.4							BQL	0.6	BQL	0.6	2.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	GAC3	08:25	0.0	7.8	11	244				BQL	BQL	BQL	BQL	2.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/9/96	1	13	98	77	40.1	0.52	GAC1																								

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase I

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/9/96	1	13	98	77	40.1	0.52	GAC2																								
10/10/96	1	13	98	77	40.4	0.53	INF1	09:53		6.9	14	433				505	505	34.4	1130	0.944	2.4	11.3	BQL	62.1	BQL	BQL	BQL	BQL	7.2	BQL	5.7
10/10/96	1	13	98	77	40.4	0.53	INF1									368	383	30.4	885	0.872	1.9	9.3	BQL	80.3	BQL	BQL	BQL	BQL	7.6	BQL	4.9
10/10/96	1	13	98	77	40.4	0.53	INF1	15:07		6.9	15	430				380	411	26.9	918	0.845	1.6	9.4	BQL	76.2	BQL	BQL	BQL	BQL	5.6	BQL	7.4
10/10/96	1	13	98	77	40.4	0.53	INF1									379	414	29	927	0.84	BQL	9.3	BQL	84.5	BQL	BQL	BQL	BQL	6.9	BQL	4.5
10/10/96	1	13	98	77	40.4	0.53	INF1									380	365	36	909	0.988	1.9	11.2	BQL	99.2	BQL	BQL	BQL	BQL	9	BQL	6.9
10/10/96	1	13	98	77	40.4	0.53	C1/0	09:47	0.6	7.1	13	922	1.5	81	40.4	45.1	106	5.8	161	1.44	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.7	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C1/0	11:38	0.8																						
10/10/96	1	13	98	77	40.4	0.53	C1/0	14:58	0.6	7.1	15	918	2.0	75	38.3																
10/10/96	1	13	98	77	40.4	0.53	C1/0	16:16	0.6																						
10/10/96	1	13	98	77	40.4	0.53	C2/0	09:34	0.7	7.3	12	914	1.8	77	40.4	7.9	34.1	1.3	45	1.54	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C2/0	11:34	0.8																						
10/10/96	1	13	98	77	40.4	0.53	C2/0	14:45	0.5	7.4	16	918	2.1	74	40.4																
10/10/96	1	13	98	77	40.4	0.53	C2/0	16:12	0.7																						
10/10/96	1	13	98	77	40.4	0.53	C3/0	09:23	0.8	7.6	12	935	1.7	79	41.8	1.1	12	BQL	14	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.9	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C3/0	11:30	0.8																						
10/10/96	1	13	98	77	40.4	0.53	C3/0	14:36	0.7	7.5	16	920	2.1	74	39.0																
10/10/96	1	13	98	77	40.4	0.53	C3/0	16:05	0.7																						
10/10/96	1	13	98	77	40.4	0.53	C4/0	09:16	0.9	7.6	11	927	1.7	79	40.4	0.1	3.8	BQL	3.9	1.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C4/0	11:27	0.7																						
10/10/96	1	13	98	77	40.4	0.53	C4/0	14:25	0.7	7.7	16	912	2.0	75	39.0																
10/10/96	1	13	98	77	40.4	0.53	C4/0	16:00	0.6																						
10/10/96	1	13	98	77	40.4	0.53	C5/0	09:00	0.6	7.8	11	904	1.7	79	40.4	BQL	1.5	BQL	1.5	1.51	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C5/0	11:22	0.6																						
10/10/96	1	13	98	77	40.4	0.53	C5/0	14:17	0.6	7.8	16	894	2.2	73	40.4																
10/10/96	1	13	98	77	40.4	0.53	C5/0	15:56	0.5																						
10/10/96	1	13	98	77	40.4	0.53	C6/0	08:42	0.5	7.9	11	864	1.7	79	40.4	BQL	0.5	BQL	0.5	1.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C6/0	11:14	0.6							BQL	0.4	BQL	0.4	1.84	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C6/0	14:04	0.3	7.8	16	810	2.1	74	39.7	BQL	0.6	BQL	0.6	1.93	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	C6/0	15:51	0.4							BQL	0.6	BQL	0.6	1.95	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/10/96	1	13	98	77	40.4	0.53	GAC3	08:24	0.0	8.0	9	270				BQL	BQL	BQL	BQL	2.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	INF1	10:16		6.8	14	435				344	361	36.6	844	1.05	2.5	12.6	BQL	68.4	BQL	BQL	BQL	BQL	10.9	BQL	7.5
10/11/96	1	13	98	76	40.4	0.53	INF1									322	336	27.7	780	0.828	2.1	9.1	BQL	71.3	BQL	BQL	BQL	BQL	5.7	BQL	5.6
10/11/96	1	13	98	76	40.4	0.53	INF1	14:53		6.8	17	424				358	378	30.7	867	0.802	1.9	10.7	BQL	72.7	BQL	BQL	BQL	BQL	8.3	BQL	6.8
10/11/96	1	13	98	76	40.4	0.53	INF1									318	341	22.6	758	0.804	BQL	8.4	BQL	64.3	BQL	BQL	BQL	BQL	3.8	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	INF1									411	426	30.2	966	1.09	BQL	10.7	BQL	78.4	BQL	BQL	BQL	BQL	10.1	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C1/0	09:47	0.7	6.9	13	931	2.0	75	34.3	59.7	138	6.7	208	1.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.1	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C1/0	11:50	0.7																						
10/11/96	1	13	98	76	40.4	0.53	C1/0	14:45	0.4	7.0	17	900	1.6	80	43.3																
10/11/96	1	13	98	76	40.4	0.53	C1/0	16:15	0.5																						
10/11/96	1	13	98	76	40.4	0.53	C2/0	09:37	0.6	7.2	13	924	2.1	74	38.5	8.4	42.1	1.2	53.7	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C2/0	11:45	0.7																						
10/11/96	1	13	98	76	40.4	0.53	C2/0	14:35	0.4	7.2	18	915	2.0	75	39.2																
10/11/96	1	13	98	76	40.4	0.53	C2/0	16:10	0.5																						
10/11/96	1	13	98	76	40.4	0.53	C3/0	09:18	0.8	7.3	13	893	2.0	75	38.5	1.2	14.5	0.3	16.8	1.55	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C3/0	11:40	0.8																						
10/11/96	1	13	98	76	40.4	0.53	C3/0	14:20	0.6	7.4	19	851	2.0	75	37.8																
10/11/96	1	13	98	76	40.4	0.53	C3/0	16:06	0.7																						
10/11/96	1	13	98	76	40.4	0.53	C4/0	09:06	0.8	7.7	12	930	1.9	76	39.8	BQL	4.8	BQL	5.3	1.6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C4/0	11:35	0.8																						
10/11/96	1	13	98	76	40.4	0.53	C4/0	14:08	0.6	7.6	18	904	1.9	76	39.2																
10/11/96	1	13	98	76	40.4	0.53	C4/0	16:04	0.6																						
10/11/96	1	13	98	76	40.4	0.53	C5/0	08:53	0.5	7.8	11	907	2.0	75	39.8	BQL	1.7	BQL	2.1	1.73	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C5/0	11:30	0.6																						
10/11/96	1	13	98	76	40.4	0.53	C5/0	13:53	0.4	7.8	18	880	2.0	75	38.5																
10/11/96	1	13	98	76	40.4	0.53	C5/0	15:59	0.4																						

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 1

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temperature of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Off-gas Ozone (%)	Contactor Transferred Ozone (mg/L)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/11/96	1	13	98	76	40.4	0.53	C6/0	08:40	0.5	7.9	11	875	2.0	75	39.2	BQL	0.6	BQL	0.8	1.6	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.2	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C6/0	11:25	0.5							BQL	0.6	BQL	0.6	1.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C6/0	13:40	0.3	7.8	18	850	1.9	76	39.2	BQL	0.7	BQL	0.7	1.66	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	C6/0	15:53	0.3							BQL	0.9	BQL	0.9	1.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	GAC3	08:25	0.0	7.9	11	283				BQL	BQL	BQL	BQL	1.79	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/11/96	1	13	98	76	40.4	0.53	GAC1																								
10/11/96	1	13	98	76	40.4	0.53	GAC2																								

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/12/96	1	25.0	60	46.4	24.6	0.53	INFI	13:41		7.1	18	424		380	410	38.5	954	0.953	BQL	14.2	BQL	103	BQL	BQL	BQL	BQL	8.5	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	INFI							332	324	35.9	825	0.998	BQL	11.4	22.5	92	BQL	BQL	BQL	BQL	7.3	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	INFI							366	388	36.1	896	0.873	BQL	12.1	BQL	87.4	BQL	BQL	BQL	BQL	6	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	INFI							377	339	38.8	864	0.91	BQL	12.3	BQL	89.8	BQL	BQL	BQL	BQL	6.8	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	INFI							340	358	27.8	832	0.934	1.8	11.2	BQL	80.3	BQL	BQL	BQL	BQL	7.6	BQL	5.4
10/12/96	1	25.0	60	46.4	24.6	0.53	C1/0	13:26	0.3	7.1	18	575	25	78.9	160	10.9	256	1.1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.7	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C1/0	15:02	0.4				25																
10/12/96	1	25.0	60	46.4	24.6	0.53	C2/0	13:14	0.4	7.3	17	889	24	21.6	91.5	3.2	119	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.8	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C2/0	14:59	0.6				25																
10/12/96	1	25.0	60	46.4	24.6	0.53	C3/0	13:07	0.4	7.4	17	924	24	4.7	43.5	0.9	50.7	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C3/0	14:56	0.6				24																
10/12/96	1	25.0	60	46.4	24.6	0.53	C4/0	12:58	0.6	7.5	17	932	24	0.9	15.1	0.3	17.3	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C4/0	14:52	0.7				24																
10/12/96	1	25.0	60	46.4	24.6	0.53	C5/0	12:50	0.6	7.6	17	929	23	0.3	8.1	BQL	9	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C5/0	14:48	0.7				23																
10/12/96	1	25.0	60	46.4	24.6	0.53	C6/0	12:40	0.4	7.8	18	888	24	BQL	1	BQL	1	1.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C6/0							BQL	3.6	BQL	3.6	1.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C6/0	14:45	0.6				24	BQL	3.7	BQL	4	1.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.3	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	C6/0							BQL	3.8	BQL	3.8	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	GAC3	12:25	0.0	8.1	16	255		BQL	BQL	BQL	BQL	1.96	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	GAC1							BQL	BQL	BQL	BQL	1.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/12/96	1	25.0	60	46.4	24.6	0.53	GAC2							BQL	BQL	BQL	BQL	1.77	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	INFI	20:22		6.9	15	427		354	357	26.4	832	1.2	BQL	10.3	BQL	72.4	BQL	BQL	BQL	BQL	6.1	BQL	6
10/13/96	1	25.0	60	47.2	24.7	0.52	INFI							370	378	BQL	840	1.06	BQL	9.7	BQL	69	BQL	BQL	BQL	BQL	6.5	BQL	6.4
10/13/96	1	25.0	60	47.2	24.7	0.52	INFI	15:13		7.0	18	422		538	546	BQL	1200	1.04	BQL	11.7	BQL	86.5	BQL	BQL	BQL	BQL	10.8	BQL	6.9
10/13/96	1	25.0	60	47.2	24.7	0.52	INFI							396	396	28.8	927	1.08	BQL	11.3	BQL	78.8	BQL	BQL	BQL	BQL	9.4	BQL	7
10/13/96	1	25.0	60	47.2	24.7	0.52	INFI							393	410	5.9	907	1	BQL	10.7	BQL	73.8	BQL	BQL	BQL	BQL	7.3	BQL	6.3
10/13/96	1	25.0	60	47.2	24.7	0.52	C1/0	10:00	0.3	7.0	14	870	24	72.7	150	11.4	241	1.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	6.1	BQL	1
10/13/96	1	25.0	60	47.2	24.7	0.52	C1/0	11:56	0.6																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C1/0	15:03	0.3	7.1	19	579	25																
10/13/96	1	25.0	60	47.2	24.7	0.52	C1/0	16:30	0.5																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C2/0	09:50	0.7	7.0	14	941	24	20.8	91.3	3.4	119	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.3	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C2/0	11:53	0.7																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C2/0	14:57	0.5	7.2	18	913	24																
10/13/96	1	25.0	60	47.2	24.7	0.52	C2/0	16:28	0.5																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C3/0	09:35	0.8	7.3	15	930	25	4.4	33.1	0.7	40	1.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C3/0	11:49	0.8																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C3/0	14:51	0.5	7.3	18	931	24																
10/13/96	1	25.0	60	47.2	24.7	0.52	C3/0	16:25	0.7																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C4/0	09:28	0.8	7.4	14	943	24	0.9	14.6	BQL	16.7	1.42	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.2	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C4/0	11:45	0.4																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C4/0	14:43	0.4	7.5	19	903	25																
10/13/96	1	25.0	60	47.2	24.7	0.52	C4/0	16:21	0.6																				

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydroger Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodie: (µg/L)	Nitrate (mg/L N	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/13/96	1	25.0	60	47.2	24.7	0.52	C5/0	09:18	0.5	7.5	14	925	24	0.2	6.5	BQL	6.7	9.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C5/0	11:42	0.7																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C5/0	14:35	0.5	7.6	20	903	24																
10/13/96	1	25.0	60	47.2	24.7	0.52	C5/0	16:14	0.6																				
10/13/96	1	25.0	60	47.2	24.7	0.52	C6/0	09:06	0.6	7.6	14	886	24	BQL	2.5	BQL	2.5	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C6/0	11:32	0.6					BQL	2.2	BQL	2.2	1.58	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C6/0	14:24	0.4	7.7	20	870	24	BQL	3.3	BQL	3.3	1.55	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	C6/0	16:18	0.4					BQL	2.6	BQL	2.6	1.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/13/96	1	25.0	60	47.2	24.7	0.52	GAC3	08:45	0.0	7.8	258	258		BQL	BQL	BQL	BQL	1.74	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	INFI	10:01		7.0	15	425		292	312	27.3	718	1.08	1.4	10.7	BQL	61	BQL	BQL	BQL	BQL	4	3.9	5.2
10/14/96	1	25.0	60	46.5	24.5	0.53	INFI							355	386	19.2	842	1.01	BQL	9.6	BQL	62.4	BQL	BQL	BQL	BQL	5.1	BQL	5.2
10/14/96	1	25.0	60	46.5	24.5	0.53	INFI	15:30		7.1	16	405		376	386	23.6	878	0.999	BQL	10.7	BQL	70	BQL	BQL	BQL	BQL	5.5	BQL	5.7
10/14/96	1	25.0	60	46.5	24.5	0.53	INFI							352	351	23.2	820	1.03	BQL	10.9	BQL	70.9	BQL	BQL	BQL	BQL	5.7	BQL	5.9
10/14/96	1	25.0	60	46.5	24.5	0.53	INFI							357	381	20.8	853	1	BQL	10.8	BQL	69.1	BQL	BQL	BQL	BQL	8.5	BQL	5.6
10/14/96	1	25.0	60	46.5	24.5	0.53	C1/0	09:53	0.5	7.1	15	895	25	82.2	173	9	270	1.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5	BQL	0.5
10/14/96	1	25.0	60	46.5	24.5	0.53	C1/0	11:51	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C1/0	15:24	0.4	7.2	17	959	25																
10/14/96	1	25.0	60	46.5	24.5	0.53	C1/0	16:25	0.5																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C2/0	09:46	0.5	7.2	15	926	24	19.9	75.1	3.2	101	1.29	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C2/0	11:48	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C2/0	15:20	0.5	7.3	18	901	24																
10/14/96	1	25.0	60	46.5	24.5	0.53	C2/0	16:23	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C3/0	09:34	0.8	7.3	15	940	25	3.9	29	0.7	35.2	1.42	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C3/0	11:42	0.9																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C3/0	14:50	0.5	7.4	18	904	25																
10/14/96	1	25.0	60	46.5	24.5	0.53	C3/0	16:21	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C4/0	09:11	0.6	7.5	15	934	24	0.8	13.7	BQL	15.3	1.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C4/0	11:40	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C4/0	14:40	0.5	7.6	18	922	24																
10/14/96	1	25.0	60	46.5	24.5	0.53	C4/0	16:19	0.6																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C5/0	08:59	0.6	7.5	15	914	25	0.2	6	BQL	6.7	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C5/0	11:37	0.8																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C5/0	14:24	0.3	7.6	20	902	24																
10/14/96	1	25.0	60	46.5	24.5	0.53	C5/0	16:16	0.7																				
10/14/96	1	25.0	60	46.5	24.5	0.53	C6/0	08:48	0.6	7.7	15	875	25	BQL	2.5	BQL	2.5	1.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C6/0	11:33	0.6					BQL	2.9	BQL	2.9	1.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C6/0	14:02	0.3	7.8	20	850	24	BQL	3.1	BQL	3.4	1.54	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.3	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	C6/0	16:12	0.5					BQL	2.8	BQL	2.8	1.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/14/96	1	25.0	60	46.5	24.5	0.53	GAC3	08:38		7.8	15	279		BQL	BQL	BQL	BQL	1.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	INFI	10:08		7.0	13	463		301	331	25.8	741	0.869	1.8	9.8	BQL	63.1	BQL	BQL	BQL	BQL	4.5	BQL	4.4
10/15/96	1	25.0	60	46.1	24.7	0.54	INFI							518	540	35.3	1200	0.894	1.6	12.1	BQL	78.7	BQL	BQL	BQL	BQL	5.2	BQL	7
10/15/96	1	25.0	60	46.1	24.7	0.54	INFI	15:10		7.1	16	422		326	361	25.5	785	0.852	0.7	8.8	BQL	57	BQL	BQL	BQL	BQL	2.4	BQL	3.6
10/15/96	1	25.0	60	46.1	24.7	0.54	INFI							301	335	22.9	731	0.896	BQL	9	BQL	54	BQL	BQL	BQL	BQL	4.5	BQL	4.6

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/15/96	1	25.0	60	46.1	24.7	0.54	INFl							326	356	24.2	780	0.919	BQL	9.1	BQL	56	BQL	BQL	BQL	BQL	4.3	BQL	4.9
10/15/96	1	25.0	60	46.1	24.7	0.54	C1/0	10:00	0.4	7.2	13	880	25	100	205	9.9	318	1.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.5	BQL	0.7
10/15/96	1	25.0	60	46.1	24.7	0.54	C1/0	12:40	0.7																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C1/0	15:07	0.4	7.2	16	889	24																
10/15/96	1	25.0	60	46.1	24.7	0.54	C1/0	16:35	0.5																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C2/0	09:53	0.6	7.3	13	935	24	15.8	70.7	2.6	91	1.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.4	BQL	0.5
10/15/96	1	25.0	60	46.1	24.7	0.54	C2/0	12:37	0.9																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C2/0	14:59	0.5	7.4	16	931	24																
10/15/96	1	25.0	60	46.1	24.7	0.54	C2/0	16:32	0.7																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C3/0	09:42	0.7	7.3	13	936	25	4	35.8	0.9	42	1.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	0.3
10/15/96	1	25.0	60	46.1	24.7	0.54	C3/0	12:35	0.9																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C3/0	14:49	0.6	7.5	17	919	24																
10/15/96	1	25.0	60	46.1	24.7	0.54	C3/0	16:29	0.8																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C4/0	08:55	0.8	7.5	12	945	24	0.7	13.5	BQL	14.7	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	C4/0	12:33	0.9																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C4/0	14:42	0.5	7.6	17	930	24																
10/15/96	1	25.0	60	46.1	24.7	0.54	C4/0	16:26	0.6																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C5/0	08:50	0.9	7.7	12	928	24	0.1	5.2	BQL	5.9	1.35	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	C5/0	12:30	0.9																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C5/0	14:34	0.4	7.7	17	925	24																
10/15/96	1	25.0	60	46.1	24.7	0.54	C5/0	16:23	0.7																				
10/15/96	1	25.0	60	46.1	24.7	0.54	C6/0	08:42	0.7	7.9	12	848	24	BQL	2.9	BQL	2.9	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	C6/0	12:25	0.7					BQL	2.5	BQL	2.5	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	C6/0	14:26	0.5	7.9	18	887	24	BQL	2.4	BQL	2.4	1.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	C6/0	16:20	0.6					BQL	2.4	BQL	2.4	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/15/96	1	25.0	60	46.1	24.7	0.54	GAC3	08:28	0.0	8.0	18	269		BQL	0.3	BQL	0.3	1.48	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	INFl	07:56		7.0	13	432		449	461	31.8	1040	0.956	2.1	11.5	BQL	73	BQL	BQL	BQL	BQL	4.7	BQL	7
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	INFl							206	233	27	552	0.977	1.1	10.5	BQL	63.2	BQL	BQL	BQL	BQL	5.5	BQL	5.9
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	INFl							416	430	25.7	952	0.921	1.7	9.4	BQL	60.1	BQL	BQL	BQL	BQL	3.8	BQL	5.2
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	INFl							359	382	26.8	848	0.902	1.9	10.4	BQL	59.4	BQL	BQL	BQL	BQL	3.8	BQL	5.2
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	INFl							346	384	24.8	832	0.937	1.3	9.9	BQL	57.7	BQL	BQL	BQL	BQL	3.7	BQL	5.1
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C1/0	07:48	0.4	7.0	13	878	24	83.9	181	8.3	278	1.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.4	BQL	0.9
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C1/0	09:18	0.5				24																
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C2/0	07:37	0.5	7.2	13	923	24	14.2	63.5	2.2	82.4	1.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.1	BQL	0.4
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C2/0	09:15	0.7				24																
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C3/0	07:30	0.7	7.4	13	948	24	3	27.6	0.7	32.8	1.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	0.2
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C3/0	09:12	0.9				24																
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C4/0	07:24	0.8	7.5	13	949	24	0.7	13.3	0.2	14.2	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C4/0	09:09	1.1				24																
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C5/0	07:08	0.7	7.6	13	932	24	0.1	5.4	BQL	5.5	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C5/0	09:05	0.9				24																
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C6/0	06:58	0.7	7.6	13	903	24	BQL	3	BQL	3	1.39	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C6/0							BQL	2.5	BQL	2.5	1.44	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C6/0	09:02	0.6				24	BQL	2.5	BQL	2.5	1.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	C6/0							BQL	2.3	BQL	2.3	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/16/96	1	25.0	60	Monitor Dow	25.0	NA	GAC3	06:50	0.0	7.7	13	277		BQL	0.3	BQL	0.3	1.41	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	INFI							326	337	24.9	771	1.38	1.6	9.2	BQL	63.6	BQL	BQL	BQL	BQL	4.2	BQL	4.4
10/21/96	1	24.5	55	43.0	24.8	0.58	INFI	17:30		7.0	12	425		347	364	27.4	832	1.23	1.2	11.1	BQL	70.7	BQL	BQL	BQL	BQL	5.9	BQL	5.1
10/21/96	1	24.5	55	43.0	24.8	0.58	INFI							320	318	30.2	776	1.23	1.4	12	BQL	81.1	BQL	BQL	BQL	BQL	6.3	BQL	6.6
10/21/96	1	24.5	55	43.0	24.8	0.58	INFI							446	446	30	1030	1.26	1.5	12.2	BQL	84.2	BQL	BQL	BQL	BQL	6.4	BQL	6.9
10/21/96	1	24.5	55	43.0	24.8	0.58	INFI							451	460	34.9	1070	1.24	1.8	13.8	BQL	96.2	BQL	BQL	BQL	BQL	7.5	BQL	7.5
10/21/96	1	24.5	55	43.0	24.8	0.58	C1/0	16:59	0.2	7.1	16	420	24	80	156	9	251	1.58	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5.5	BQL	0.6
10/21/96	1	24.5	55	43.0	24.8	0.58	C1/0	17:58	0.3																				
10/21/96	1	24.5	55	43.0	24.8	0.58	C2/0	16:52	0.4	7.3	12	892	25	15.4	61.1	2.3	81.7	1.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.9	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C2/0	17:56	0.8																				
10/21/96	1	24.5	55	43.0	24.8	0.58	C3/0	16:45	0.8	7.3	12	931	24	3.3	28.1	0.9	34	1.83	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C3/0	17:53	1.1																				
10/21/96	1	24.5	55	43.0	24.8	0.58	C4/0	16:38	0.8	7.4	12	927	24	0.7	13.1	BQL	13.8	1.9	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C4/0	17:50	1.1																				
10/21/96	1	24.5	55	43.0	24.8	0.58	C5/0	16:30	0.5	7.4	13	874	26	0.1	5.8	BQL	5.9	1.83	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C5/0	17:46	0.8																				
10/21/96	1	24.5	55	43.0	24.8	0.58	C6/0	16:20	0.5	7.6	14	774	26	0.6	21.9	1.1	25.4	2.52	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.8	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C6/0							BQL	3.2	BQL	3.2	1.94	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C6/0	17:42	0.7					BQL	2.3	BQL	2.3	2.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	C6/0							BQL	2	BQL	2	1.95	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/21/96	1	24.5	55	43.0	24.8	0.58	GAC3	16:03	0.0	7.3	12	266		BQL	0.3	BQL	0.3	1.79	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	INFI	10:20		7.0	13	350		337	397	24.4	846	1.07	1.4	9.7	BQL	64.9	BQL	BQL	BQL	BQL	6.6	BQL	5.1
10/22/96	1	24.5	56	42.9	25.7	0.60	INFI							329	353	21.1	778	1.11	1.3	7.9	BQL	56.4	BQL	BQL	BQL	BQL	5.4	BQL	3.7
10/22/96	1	24.5	56	42.9	25.7	0.60	INFI	15:31		7.0	13	336		291	324	21.5	709	1.07	1.5	8.2	BQL	53.2	BQL	BQL	BQL	BQL	5.2	BQL	4.4
10/22/96	1	24.5	56	42.9	25.7	0.60	INFI							320	361	23.6	786	1.03	1.3	9.6	BQL	60.1	BQL	BQL	BQL	BQL	6.5	BQL	4.3
10/22/96	1	24.5	56	42.9	25.7	0.60	INFI							358	389	23.6	854	1.14	1.3	10.5	BQL	62.5	BQL	BQL	BQL	BQL	5.7	BQL	3.8
10/22/96	1	24.5	56	42.9	25.7	0.60	C1/0	10:15	0.0	7.0	13	325	27	70.6	140	8.8	225	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.7	BQL	0.5
10/22/96	1	24.5	56	42.9	25.7	0.60	C1/0	11:10	0.1																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C1/0	14:46	0.2	7.1	15	318	24																
10/22/96	1	24.5	56	42.9	25.7	0.60	C1/0	16:25	0.3																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C2/0	09:37	0.5	7.2	11	830	24	18.3	75.5	2.7	99.4	1.54	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.8	BQL	0.1
10/22/96	1	24.5	56	42.9	25.7	0.60	C2/0	11:06	0.6																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C2/0	14:22	0.6	7.3	12	885	24																
10/22/96	1	24.5	56	42.9	25.7	0.60	C2/0	16:21	0.9																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C3/0	09:13	1.0	7.3	11	927	24	3.3	28.2	0.7	33.7	1.69	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.5	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C3/0	11:01	1.1																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C3/0	14:14	0.8	7.4	12	952	24																
10/22/96	1	24.5	56	42.9	25.7	0.60	C3/0	16:18	1.1																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C4/0	09:07	1.0	7.4	11	943	24	0.7	13	0.1	14.8	1.82	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C4/0	10:54	1.1																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C4/0	14:05	1.1	7.6	12	951	24																

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/22/96	1	24.5	56	42.9	25.7	0.60	C4/0	16:15	1.1																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C5/0	08:58	0.7	7.5	10	930	25	0.1	5.6	BQL	5.7	1.95	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C5/0	10:44	0.8																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C5/0	13:55	0.6	7.6	12	914	26																
10/22/96	1	24.5	56	42.9	25.7	0.60	C5/0	16:07	0.8																				
10/22/96	1	24.5	56	42.9	25.7	0.60	C6/0	08:41	0.9	7.5	10	902	26	BQL	2	BQL	2	2.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C6/0	10:40	1.0					BQL	2.1	BQL	2.1	2.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C6/0	13:39	0.7	7.7	12	900	25	BQL	2.5	BQL	2.5	2.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	C6/0	16:03	0.8					BQL	2.6	BQL	2.6	2.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	GAC3	08:15	0.0	7.6	9	329		BQL	0.3	BQL	0.3	1.92	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	GAC1							BQL	0.3	BQL	0.3	1.73	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/22/96	1	24.5	56	42.9	25.7	0.60	GAC2							BQL	0.4	BQL	0.4	1.97	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	INF1	10:58		6.8	13	380		427	467	29	1020	1.14	1.7	11.1	BQL	74.3	BQL	BQL	BQL	BQL	9.4	BQL	4.5
10/23/96	1	24.5	56	42.4	25.9	0.61	INF1							369	404	25.5	883	1.14	1.3	9.7	BQL	62.4	BQL	BQL	BQL	BQL	7.4	BQL	3.6
10/23/96	1	24.5	56	42.4	25.9	0.61	INF1	14:40		7.2	15	423		276	314	22.4	685	1.1	1	8.9	BQL	53.3	BQL	BQL	BQL	BQL	4.4	BQL	4.7
10/23/96	1	24.5	56	42.4	25.9	0.61	INF1							393	435	26.8	944	1.11	1.7	10.4	BQL	67.1	BQL	BQL	BQL	BQL	6.1	BQL	4.3
10/23/96	1	24.5	56	42.4	25.9	0.61	INF1							312	332	25.4	748	1.06	BQL	9.5	BQL	58.4	BQL	BQL	BQL	BQL	6.7	BQL	4.4
10/23/96	1	24.5	56	42.4	25.9	0.61	C1/0	10:21	0.1	7.1	15	363	23	73.2	158	8	244	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	5	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C1/0	11:34	0.5																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C1/0	14:26	0.4	7.2	16	805	24																
10/23/96	1	24.5	56	42.4	25.9	0.61	C1/0	15:58	0.4																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C2/0	10:13	0.6	7.1	12	920	25	5.9	67.5	2.3	88.5	1.62	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.8	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C2/0	11:30	0.8																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C2/0	14:18	0.6	7.5	16	941	25																
10/23/96	1	24.5	56	42.4	25.9	0.61	C2/0	15:56	0.7																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C3/0	10:02	0.7	7.3	12	940	24	3.1	27.4	0.8	33	1.76	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.7	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C3/0	11:27	1.1																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C3/0	14:04	0.7	7.4	16	894	24																
10/23/96	1	24.5	56	42.4	25.9	0.61	C3/0	15:53	1.1																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C4/0	09:55	0.7	7.4	11	935	25	0.7	12.7	BQL	14.5	1.94	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C4/0	11:24	1.0																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C4/0	13:55	0.7	7.3	15	933	25																
10/23/96	1	24.5	56	42.4	25.9	0.61	C4/0	15:50	0.9																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C5/0	09:48	0.4	7.2	11	911	26	0.2	5.6	BQL	6.5	2.08	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C5/0	11:21	0.7																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C5/0	13:48	0.4	7.7	16	910	26																
10/23/96	1	24.5	56	42.4	25.9	0.61	C5/0	15:47	0.6																				
10/23/96	1	24.5	56	42.4	25.9	0.61	C6/0	09:12	0.5	7.7	11	886	26	BQL	2.2	BQL	2.2	2.15	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C6/0	11:18	0.4					BQL	2	BQL	2	2.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C6/0	13:29	0.6	7.9	16	897	26	BQL	2.5	BQL	2.5	2.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	C6/0	15:45	0.7					BQL	2.6	BQL	2.6	2.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/23/96	1	24.5	56	42.4	25.9	0.61	GAC3	09:23	0.0	7.8	10	260		BQL	0.3	BQL	0.3	2.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	INF1	10:10		6.7	13	325		354	386	25.6	853	0.853	1.2	10.4	BQL	64.7	BQL	BQL	BQL	BQL	6.8	BQL	4.7

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/24/96	1	24.5	57	42.7	24.8	0.58	INFI							287	326	24.9	712	0.866	1	9.5	BQL	55.2	BQL	BQL	BQL	BQL	4.2	BQL	4
10/24/96	1	24.5	57	42.7	24.8	0.58	INFI	15:24		6.8	18	382		387	456	29.8	974	0.833	1.6	11.8	BQL	74	BQL	BQL	BQL	BQL	7.9	BQL	5.5
10/24/96	1	24.5	57	42.7	24.8	0.58	INFI							321	352	25.3	784	0.787	1.2	10.1	BQL	63.4	BQL	BQL	BQL	BQL	6.7	BQL	4.7
10/24/96	1	24.5	57	42.7	24.8	0.58	INFI							334	352	28.7	810	0.866	1.4	11.6	BQL	69.7	BQL	BQL	BQL	BQL	7.5	BQL	5.1
10/24/96	1	24.5	57	42.7	24.8	0.58	C1/0	09:40	0.0	7.0	14	300	27	77.4	165	8.6	256	1.11	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.9	BQL	0.4
10/24/96	1	24.5	57	42.7	24.8	0.58	C1/0	11:36	0.4																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C1/0	15:11	0.3	7.1	17	620	24																
10/24/96	1	24.5	57	42.7	24.8	0.58	C1/0	16:29	0.4																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C2/0	09:30	0.3	7.1	12	897	25	15.4	66.5	2.3	86.9	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.7	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C2/0	11:33	0.6																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C2/0	14:58	0.6	7.1	16	925	25																
10/24/96	1	24.5	57	42.7	24.8	0.58	C2/0	16:26	0.6																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C3/0	09:20	0.8	7.1	12	950	24	3.4	29.6	0.6	35.2	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C3/0	11:31	1.2																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C3/0	14:38	0.7	7.3	16	945	24																
10/24/96	1	24.5	57	42.7	24.8	0.58	C3/0	16:22	0.8																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C4/0	09:10	0.8	7.4	11	940	24	0.8	15.1	BQL	17	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C4/0	11:28	1.0																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C4/0	14:31	0.7	7.4	16	931	25																
10/24/96	1	24.5	57	42.7	24.8	0.58	C4/0	16:20	0.8																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C5/0	09:00	0.5	7.5	11	910	26	0.2	6.3	BQL	7.2	1.74	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C5/0	11:25	0.7																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C5/0	14:09	0.5	7.5	17	885	26																
10/24/96	1	24.5	57	42.7	24.8	0.58	C5/0	16:18	0.6																				
10/24/96	1	24.5	57	42.7	24.8	0.58	C6/0	08:42	0.3	7.6	10	743	26	BQL	2.1	BQL	2.1	1.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C6/0	11:21	0.7					BQL	2.2	BQL	2.2	1.57	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C6/0	14:20	0.5	7.7	17	911	26	BQL	2.9	BQL	2.9	1.64	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	C6/0	16:14	0.6					BQL	2.8	BQL	2.8	1.77	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/24/96	1	24.5	57	42.7	24.8	0.58	GAC3	08:25	0.0	7.7	10	335		BQL	0.3	BQL	0.3	1.66	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	INFI	11:09		6.9	19	399		245	275	21.9	612	0.807	1.7	8.7	BQL	51.3	BQL	BQL	BQL	BQL	4.1	BQL	4
10/25/96	1	24.5	57	42.8	26.9	0.63	INFI							274	313	22.2	678	0.851	1.3	9.6	BQL	49	BQL	BQL	BQL	BQL	4.8	BQL	3.8
10/25/96	1	24.5	57	42.8	26.9	0.63	INFI	14:44		7.0	15	398		254	289	24.3	645	0.84	1.4	9.6	BQL	57.7	BQL	BQL	BQL	BQL	4.9	BQL	4.3
10/25/96	1	24.5	57	42.8	26.9	0.63	INFI							284	320	23.7	703	0.842	1.5	9.3	BQL	53.4	BQL	BQL	BQL	BQL	5.2	BQL	5.7
10/25/96	1	24.5	57	42.8	26.9	0.63	INFI							250	282	23.6	631	0.833	1.6	8.6	BQL	55.1	BQL	BQL	BQL	BQL	4.9	BQL	5.2
10/25/96	1	24.5	57	42.8	26.9	0.63	C1/0	10:25	0.2	7.1	19	376	26	70.3	157	7.9	240	1.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.7	BQL	0.3
10/25/96	1	24.5	57	42.8	26.9	0.63	C1/0	11:31	0.3																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C1/0	14:07	0.2	7.1	18	381	26																
10/25/96	1	24.5	57	42.8	26.9	0.63	C1/0	15:11	0.2																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C2/0	10:22	0.4	7.2	14	896	26	16.6	72.9	2.4	94.5	1.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.6	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C2/0	11:28	0.7																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C2/0	14:02	0.4	7.2	15	884	26																
10/25/96	1	24.5	57	42.8	26.9	0.63	C2/0	15:08	0.5																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C3/0	10:07	0.7	7.4	15	921	25	3	28.1	0.5	33.1	1.34	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.5	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
10/25/96	1	24.5	57	42.8	26.9	0.63	C3/0	11:26	0.8																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C3/0	13:53	0.6	7.4	15	935	25																
10/25/96	1	24.5	57	42.8	26.9	0.63	C3/0	15:06	0.7																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C4/0	09:58	0.6	7.5	15	933	26	0.6	11.9	BQL	13.5	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C4/0	11:23	0.8																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C4/0	13:43	0.6	7.5	15	931	26																
10/25/96	1	24.5	57	42.8	26.9	0.63	C4/0	15:03	0.6																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C5/0	09:00	0.4	7.6	15	893	27	0.1	5.2	BQL	6	1.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C5/0	11:21	0.5																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C5/0	13:38	0.3	7.6	15	899	27																
10/25/96	1	24.5	57	42.8	26.9	0.63	C5/0	15:01	0.4																				
10/25/96	1	24.5	57	42.8	26.9	0.63	C6/0	08:48	0.5	7.7	14	860	27	BQL	1.9	BQL	1.9	1.61	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C6/0	11:18	0.6					BQL	2	BQL	2	1.67	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C6/0	13:27	0.5	7.7	16	881	27	BQL	2.3	BQL	2.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	C6/0	14:58	0.6					BQL	2.5	BQL	2.5	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	GAC3	08:34	0.0	7.8	13	283		BQL	0.3	BQL	0.3	1.86	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	GAC1							BQL	0.3	BQL	0.3	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/25/96	1	24.5	57	42.8	26.9	0.63	GAC2							BQL	BQL	BQL	BQL	1.34	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	INF1	10:30		6.9	14	331		285	339	22.5	722	0.658	BQL	8.8	BQL	52.9	BQL	BQL	BQL	BQL	8.8	BQL	4.6
10/26/96	1	24.5	57	43.5	27.7	0.64	INF1							324	362	20.9	773	0.678	BQL	8.4	BQL	48.7	BQL	BQL	BQL	BQL	4.7	BQL	4.6
10/26/96	1	24.5	57	43.5	27.7	0.64	INF1	14:33		7.0	15	308		319	359	22	768	0.524	BQL	8.6	BQL	49.3	BQL	BQL	BQL	BQL	5.3	BQL	4.6
10/26/96	1	24.5	57	43.5	27.7	0.64	INF1							298	344	20.7	730	0.47	BQL	8.8	BQL	48.7	BQL	BQL	BQL	BQL	6	BQL	3.6
10/26/96	1	24.5	57	43.5	27.7	0.64	INF1							301	341	20.9	728	0.584	BQL	8.2	BQL	46.4	BQL	BQL	BQL	BQL	5.8	BQL	4.5
10/26/96	1	24.5	57	43.5	27.7	0.64	C1/0	10:02	0.0	7.1	16	312	27	57.3	130	6.6	199	0.945	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.5	BQL	0.6
10/26/96	1	24.5	57	43.5	27.7	0.64	C1/0	11:40	0.2																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C1/0	14:17	0.0	7.2	16	284	27																
10/26/96	1	24.5	57	43.5	27.7	0.64	C1/0	15:20	0.0																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C2/0	09:44	0.2	6.8	15	609	26	13	56	1.8	73.1	1.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.3	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C2/0	11:37	0.3																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C2/0	14:07	0.2	7.3	17	563	26																
10/26/96	1	24.5	57	43.5	27.7	0.64	C2/0	15:16	0.2																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C3/0	09:36	0.2	7.3	14	880	27	3.6	32.6	0.6	38.1	1.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C3/0	11:34	0.5																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C3/0	13:58	0.2	7.4	16	845	26																
10/26/96	1	24.5	57	43.5	27.7	0.64	C3/0	15:11	0.3																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C4/0	09:28	0.4	7.4	14	902	26	0.6	10.2	BQL	11.6	1.21	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C4/0	11:31	0.4																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C4/0	13:49	0.2	7.5	17	812	26																
10/26/96	1	24.5	57	43.5	27.7	0.64	C4/0	15:05	0.3																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C5/0	09:07	0.2	7.6	16	664	27	BQL	4.6	BQL	5.2	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.6	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C5/0	11:28	0.2																				
10/26/96	1	24.5	57	43.5	27.7	0.64	C5/0	13:28	0.1	7.7	18	545	27																
10/26/96	1	24.5	57	43.5	27.7	0.64	C5/0	15:02	0.1																				

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydroger Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitro benzene (µg/L)	2,4-Dinitro toluene (µg/L)	2,6-Dinitro toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/26/96	1	24.5	57	43.5	27.7	0.64	C6/0	08:31	0.3	7.7	17	773	27	BQL	1.7	BQL	2	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.3	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C6/0	11:24	0.3					BQL	2.2	BQL	2.6	1.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C6/0	13:16	0.2	7.9	17	790	27	BQL	2.2	BQL	2.7	1.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.5	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	C6/0	14:57	0.3					BQL	2.3	BQL	2.7	1.44	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/26/96	1	24.5	57	43.5	27.7	0.64	GAC3	08:15	0.0	7.7	15	260		BQL	BQL	BQL	BQL	1.33	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	INF1	10:32		6.8	12	296		262	312	20.2	661	0.649	BQL	8.3	BQL	49.9	BQL	BQL	BQL	BQL	4.8	BQL	3.7
10/27/96	1	24.5	55	42.2	24.3	0.58	INF1							251	292	18.1	617	0.712	1.5	7.4	BQL	40	BQL	BQL	BQL	BQL	3.4	BQL	3.2
10/27/96	1	24.5	55	42.2	24.3	0.58	INF1	16:33		7.0	13	309		319	370	21.7	785	0.732	BQL	8.4	BQL	56.3	BQL	BQL	BQL	BQL	5.4	BQL	4.2
10/27/96	1	24.5	55	42.2	24.3	0.58	INF1							263	307	20.1	650	0.766	BQL	7.9	BQL	43.8	BQL	BQL	BQL	BQL	5.2	BQL	3.3
10/27/96	1	24.5	55	42.2	24.3	0.58	INF1							249	293	17.8	624	0.804	BQL	7	BQL	48.5	BQL	BQL	BQL	BQL	4.5	BQL	3.9
10/27/96	1	24.5	55	42.2	24.3	0.58	C1/0	10:24	0.0	6.7	12	291	27	65.6	142	8.6	221	1.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.6	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C1/0	14:54	0.1																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C1/0	16:23	0.0	7.1	14	286	27																
10/27/96	1	24.5	55	42.2	24.3	0.58	C1/0	17:00	0.1																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C2/0	09:45	0.0	7.1	13	297	24	13.1	57.2	1.9	74.5	1.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.3	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C2/0	14:52	0.1																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C2/0	16:04	0.0	7.3	15	343	25																
10/27/96	1	24.5	55	42.2	24.3	0.58	C2/0	16:58	0.5																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C3/0	09:32	0.1	7.2	12	535	26	2.1	18.9	0.3	22.4	2.57	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C3/0	14:49	0.3																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C3/0	15:56	0.2	7.3	15	539	25																
10/27/96	1	24.5	55	42.2	24.3	0.58	C3/0	16:56	0.6																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C4/0	09:23	0.2	7.2	11	642	24	0.4	8.2	BQL	9.3	1.32	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C4/0	14:46	0.2																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C4/0	15:35	0.2	7.4	16	544	26																
10/27/96	1	24.5	55	42.2	24.3	0.58	C4/0	16:53	0.4																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C5/0	09:16	0.1	7.4	11	516	26	BQL	3.1	BQL	3.5	1.51	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C5/0	14:43	0.1																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C5/0	15:19	0.1	7.6	15	314	26																
10/27/96	1	24.5	55	42.2	24.3	0.58	C5/0	16:50	0.2																				
10/27/96	1	24.5	55	42.2	24.3	0.58	C6/0	09:00	0.1	7.3	10	505	25	BQL	1.4	BQL	1.4	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C6/0	14:34	0.1					BQL	1.1	BQL	1.1	1.43	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C6/0	15:08	0.1	7.7	15	460	26	0.2	1.7	BQL	1.9	1.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	C6/0	16:48	0.1					BQL	1.4	BQL	1.4	1.47	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/27/96	1	24.5	55	42.2	24.3	0.58	GAC3	08:50	0.0	7.7	10	265		BQL	BQL	BQL	BQL	1.75	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	INF1	11:04		6.6	13	415		273	336	19.2	691	0.645	1.1	8.1	BQL	44.6	BQL	BQL	BQL	BQL	5.6	BQL	3.4
10/28/96	1	24.5	56	43.3	27.2	0.63	INF1							282	341	19.3	709	0.723	1.1	8.2	BQL	48.3	BQL	BQL	BQL	BQL	5.3	BQL	3.4
10/28/96	1	24.5	56	43.3	27.2	0.63	INF1	15:46		6.9	14	415		254	298	20.4	634	0.719	1.1	8.8	BQL	45.7	BQL	BQL	BQL	BQL	3.4	BQL	3
10/28/96	1	24.5	56	43.3	27.2	0.63	INF1							275	327	21.9	687	0.755	1.1	8.7	BQL	45.8	BQL	BQL	BQL	BQL	4.3	BQL	3
10/28/96	1	24.5	56	43.3	27.2	0.63	INF1							247	291	20.2	620	0.734	1.1	8.3	BQL	44	BQL	BQL	BQL	BQL	4.7	BQL	3.8
10/28/96	1	24.5	56	43.3	27.2	0.63	C1/0	10:33	0.2	6.9	15	414	29	69.1	157	7.5	238	1.01	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.6	BQL	0.3
10/28/96	1	24.5	56	43.3	27.2	0.63	C1/0	12:09	0.3																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C1/0	15:16	0.2	7.0	17	410	26																

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydroger Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodie: (µg/L)	Nitrate (mg/L N	1,3-Dinitro benzene (µg/L)	2,4-Dinitro toluene (µg/L)	2,6-Dinitro toluene (µg/L)	2-Amino-4,6-dinitrotoluenc (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/28/96	1	24.5	56	43.3	27.2	0.63	C1/0	16:13	0.3																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C2/0	10:25	0.5	7.0	13	920	26	13.4	60.3	1.9	77.9	1.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.3	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C2/0	12:06	0.6																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C2/0	15:08	0.3	7.2	15	930	26																
10/28/96	1	24.5	56	43.3	27.2	0.63	C2/0	16:11	0.7																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C3/0	10:20	0.7	7.1	13	943	26	2.5	23.6	0.4	27.8	1.34	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C3/0	12:02	0.8																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C3/0	15:02	0.6	7.4	15	939	26																
10/28/96	1	24.5	56	43.3	27.2	0.63	C3/0	16:09	0.6																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C4/0	10:11	0.9	7.2	13	935	32	0.7	14.2	BQL	15.9	1.35	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C4/0	11:54	1.7																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C4/0	14:56	0.3	7.5	16	922	28																
10/28/96	1	24.5	56	43.3	27.2	0.63	C4/0	16:07	0.5																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C5/0	10:05	0.5	7.2	12	888	27	0.2	8	BQL	8.6	1.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C5/0	11:51	0.6																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C5/0	14:49	0.4	7.6	16	901	27																
10/28/96	1	24.5	56	43.3	27.2	0.63	C5/0	16:05	0.4																				
10/28/96	1	24.5	56	43.3	27.2	0.63	C6/0	08:36	0.4	7.5	10	890	27	BQL	1.6	BQL	1.6	1.06	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C6/0	11:46	0.6					BQL	1.6	BQL	1.6	1.26	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C6/0	14:27	0.6	7.7	16	922	27	BQL	4.2	BQL	4.2	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	C6/0	16:03	0.6					BQL	2.3	BQL	2.3	1.7	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/28/96	1	24.5	56	43.3	27.2	0.63	GAC3	08:20	0.0	7.7	13	410		BQL	BQL	BQL	BQL	1.54	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	INF1	10:00		6.9	13	370		412	450	25.7	970	0.37	1.4	10	BQL	60.5	BQL	BQL	BQL	BQL	6.7	BQL	3.9
10/29/96	1	24.5	57	43.1	26.9	0.62	INF1							295	348	18.6	728	0.697	1.2	8.8	BQL	49.2	BQL	BQL	BQL	BQL	4	BQL	3.1
10/29/96	1	24.5	57	43.1	26.9	0.62	INF1	14:55		7.2	14	406		286	335	20.6	702	0.649	1.1	8.3	BQL	43	BQL	BQL	BQL	BQL	4.9	BQL	3.4
10/29/96	1	24.5	57	43.1	26.9	0.62	INF1							294	358	19.7	739	0.658	1.1	8.5	BQL	51.1	BQL	BQL	BQL	BQL	3.6	BQL	3.3
10/29/96	1	24.5	57	43.1	26.9	0.62	INF1							297	354	21.5	736	0.66	1	8.4	BQL	46.5	BQL	BQL	BQL	BQL	3.4	BQL	3.7
10/29/96	1	24.5	57	43.1	26.9	0.62	C1/0	09:34	0.2	7.0	16	385	25	75.5	175	8	264	0.911	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.7	BQL	0.3
10/29/96	1	24.5	57	43.1	26.9	0.62	C1/0	01:54	0.2																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C1/0	14:04	0.2	7.3	13	996	29																
10/29/96	1	24.5	57	43.1	26.9	0.62	C1/0	17:02	0.0																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C2/0	09:22	0.4	7.2	14	909	25	14	64.7	2	83.4	1.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.5	BQL	0.2
10/29/96	1	24.5	57	43.1	26.9	0.62	C2/0	10:51	0.5																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C2/0	13:57	0.3	7.4	14	874	25																
10/29/96	1	24.5	57	43.1	26.9	0.62	C2/0	16:59	0.4																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C3/0	09:12	0.6	7.3	13	933	25	2.2	22.1	0.4	25.7	1.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C3/0	10:46	0.7																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C3/0	13:43	0.4	7.6	15	920	26																
10/29/96	1	24.5	57	43.1	26.9	0.62	C3/0	16:54	0.7																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C4/0	09:05	0.5	7.4	13	942	25	0.7	13.4	BQL	14.9	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C4/0	10:44	0.5																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C4/0	13:35	0.2	7.7	15	875	26																
10/29/96	1	24.5	57	43.1	26.9	0.62	C4/0	16:50	0.4																				

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydroger Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodie: (µg/L)	Nitrate (mg/L N	1,3-Dinitro-benzene (µg/L)	2,4-Dinitro-toluene (µg/L)	2,6-Dinitro-toluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitro-toluene (µg/L)	3-Nitro-toluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitro-toluene (µg/L)	HMX (µg/L)	Nitro-benzene (µg/L)	Tetryl (µg/L)
10/29/96	1	24.5	57	43.1	26.9	0.62	C5/0	08:55	0.2	7.5	13	884	26	0.1	5.8	BQL	5.9	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C5/0	10:41	0.4																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C5/0	13:24	0.2	7.8	15	825	26																
10/29/96	1	24.5	57	43.1	26.9	0.62	C5/0	16:46	0.4																				
10/29/96	1	24.5	57	43.1	26.9	0.62	C6/0	08:36	0.3	7.5	14	865	26	BQL	2	BQL	2	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C6/0	10:39	0.4					BQL	2	BQL	2	1.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C6/0	13:15	0.2	7.9	16	826	26	BQL	2.2	BQL	2.2	1.18	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	C6/0	16:41	0.5					BQL	2.3	BQL	2.3	1.34	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	GAC3	08:25	0.0	7.7	13	299		BQL	BQL	BQL	BQL	1.44	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	GAC1							BQL	BQL	BQL	BQL	1.24	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/29/96	1	24.5	57	43.1	26.9	0.62	GAC2							BQL	BQL	BQL	BQL	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	INF1	09:05		7.3	11	339		289	342	17.5	706	0.658	1	7.6	BQL	41.7	BQL	BQL	BQL	BQL	4.3	BQL	3
10/30/96	1	24.5	56	41.6	23.9	0.57	INF1							268	315	16.8	645	3.85	1.1	7.7	BQL	30	BQL	BQL	BQL	BQL	3.5	BQL	3.1
10/30/96	1	24.5	56	41.6	23.9	0.57	INF1							255	307	19.7	644	0.672	1	8.1	BQL	43.8	BQL	BQL	BQL	BQL	6.1	BQL	2.9
10/30/96	1	24.5	56	41.6	23.9	0.57	INF1							292	326	18.2	689	0.646	BQL	7.8	BQL	36.9	BQL	BQL	BQL	BQL	4.8	BQL	3.3
10/30/96	1	24.5	56	41.6	23.9	0.57	INF1							319	374	19.2	773	0.689	BQL	8.9	BQL	42.4	BQL	BQL	BQL	BQL	5.5	BQL	3.9
10/30/96	1	24.5	56	41.6	23.9	0.57	C1/0	08:30	0.2	7.5	11	316	27	60	146	6.7	217	0.704	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.3	BQL	0.4
10/30/96	1	24.5	56	41.6	23.9	0.57	C2/0	08:21	0.8	7.5	10	951	24	13.4	76.2	1.9	93.8	0.73	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.3	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C3/0	08:14	0.6	7.6	10	930	25	2.6	26.9	0.4	31.2	1.12	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C4/0	08:08	0.4	7.8	9	904	30	0.5	11.5	BQL	12.4	1.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.4	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C5/0	07:58	0.5	7.9	9	915	25	BQL	5.1	BQL	5.1	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C6/0	07:47	3.8	7.9	9	973	23	BQL	1.6	BQL	1.6	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C6/0							BQL	2.5	BQL	2.5	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C6/0	09:16	0.9					BQL	3.3	BQL	3.3	1.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	C6/0							BQL	2	BQL	2	1.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
10/30/96	1	24.5	56	41.6	23.9	0.57	GAC3	07:40	0.0	8.1	7	300		BQL	BQL	BQL	BQL	1.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	INF1	15:24		7.0	14	435		284	330	21.2	699	0.68	1	7.5	BQL	45.6	BQL	BQL	BQL	BQL	5.4	BQL	4.4
11/4/96	1	24.0	60	46.0	23.6	0.51	INF1							306	312	22.4	714	0.545	1.3	9.5	BQL	53	BQL	BQL	BQL	BQL	6.2	BQL	3.7
11/4/96	1	24.0	60	46.0	23.6	0.51	INF1							268	296	25.7	672	0.59	1.4	10.1	BQL	56.7	BQL	BQL	BQL	BQL	9.9	BQL	4.5
11/4/96	1	24.0	60	46.0	23.6	0.51	INF1							290	334	20.3	713	0.563	0.9	9.2	BQL	47.3	BQL	BQL	BQL	BQL	7.4	BQL	3.8
11/4/96	1	24.0	60	46.0	23.6	0.51	INF1							281	331	22	702	0.531	1.3	8.7	BQL	49.7	BQL	BQL	BQL	BQL	5.2	BQL	3.4
11/4/96	1	24.0	60	46.0	23.6	0.51	C1/0	15:12	0.1	7.1	15	559	24	54.9	133	6.6	199	0.676	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.4	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C1/0	16:17	0.3				25																
11/4/96	1	24.0	60	46.0	23.6	0.51	C2/0	14:56	0.6	7.2	14	930	24	13.5	71.9	2	90	0.822	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.6	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C2/0	16:08	0.8				24																
11/4/96	1	24.0	60	46.0	23.6	0.51	C3/0	14:51	0.8	7.3	14	949	24	3.6	31.4	0.6	37.2	1.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.6	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C3/0	16:08	1.1				24																
11/4/96	1	24.0	60	46.0	23.6	0.51	C4/0	14:51	0.7	7.5	14	937	24	0.4	9.7	BQL	10.1	1.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C4/0	16:33	1.2				23																
11/4/96	1	24.0	60	46.0	23.6	0.51	C5/0	14:45	0.6	7.6	14	922	24	0.1	4.4	BQL	4.5	0.992	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C5/0	16:28	1.1				24																
11/4/96	1	24.0	60	46.0	23.6	0.51	C6/0	14:32	0.8	7.6	16	884	24	BQL	2.3	BQL	2.3	1.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C6/0	16:24	0.8				25	BQL	2.8	BQL	2.8	1.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
11/4/96	1	24.0	60	46.0	23.6	0.51	C6/0							BQL	2	BQL	2	1.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	C6/0							BQL	2	BQL	2	1.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/4/96	1	24.0	60	46.0	23.6	0.51	GAC3	14:06	0.0	7.4	14	275		BQL	BQL	BQL	BQL	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	INF1	09:32		6.9	11	436		218	270	21.1	577	0.69	0.9	9.4	BQL	48.2	BQL	BQL	BQL	BQL	5.4	BQL	3.7
11/5/96	1	24.0	60	45.6	25.6	0.56	INF1							354	387	19.5	824	0.578	1.1	8.2	BQL	46.3	BQL	BQL	BQL	BQL	4.7	BQL	3
11/5/96	1	24.0	60	45.6	25.6	0.56	INF1	15:26		7.0	14	422		359	391	20.9	836	0.687	1.1	8.6	BQL	47.1	BQL	BQL	BQL	BQL	5	BQL	3.3
11/5/96	1	24.0	60	45.6	25.6	0.56	INF1							198	254	19.7	535	0.759	0.8	7.5	BQL	46.5	BQL	BQL	BQL	BQL	4.8	BQL	3.8
11/5/96	1	24.0	60	45.6	25.6	0.56	INF1							215	268	19.6	568	0.71	1.3	7.3	BQL	48.8	BQL	BQL	BQL	BQL	5	BQL	3.2
11/5/96	1	24.0	60	45.6	25.6	0.56	C1/0	09:19	0.4	7.0	11	813	23	45.6	106	50	205	1.02	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.1	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C1/0	12:11	0.7																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C1/0	15:19	0.4	7.1	14	896	23																
11/5/96	1	24.0	60	45.6	25.6	0.56	C1/0	17:12	0.4																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C2/0	09:05	0.7	7.1	11	950	24	11.7	58.6	1.8	74	1.08	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.9	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C2/0	12:07	0.9																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C2/0	15:10	0.7	7.3	14	957	24																
11/5/96	1	24.0	60	45.6	25.6	0.56	C2/0	17:08	0.9																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C3/0	09:05	1.0	7.3	11	957	24	2.5	25	0.4	29	1.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C3/0	12:07	1.2																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C3/0	15:05	0.6	7.4	15	952	24																
11/5/96	1	24.0	60	45.6	25.6	0.56	C3/0	17:01	0.8																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C4/0	09:11	1.0	7.4	11	952	25	0.5	11	BQL	12.2	1.07	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.7	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C4/0	11:59	0.9																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C4/0	14:53	0.7	7.5	15	936	25																
11/5/96	1	24.0	60	45.6	25.6	0.56	C4/0	16:49	0.8																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C5/0	08:43	1.0	7.5	10	949	24	0.1	5.3	BQL	5.4	1.1	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C5/0	11:52	1.1																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C5/0	14:42	0.7	7.6	15	930	24																
11/5/96	1	24.0	60	45.6	25.6	0.56	C5/0	16:40	0.7																				
11/5/96	1	24.0	60	45.6	25.6	0.56	C6/0	08:32	0.6	7.5	9	904	25	BQL	1.8	BQL	1.8	0.906	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C6/0	11:46	0.8					BQL	2.2	BQL	2.2	1.16	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C6/0	14:34	0.6	7.6	15	893	24	BQL	1.9	BQL	1.9	1.34	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	C6/0	16:30	0.5					BQL	2.1	BQL	2.1	1.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	GAC3	08:16	0.0	7.8	8	243		BQL	BQL	BQL	BQL	1.78	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	GAC1							BQL	BQL	BQL	BQL	1.16	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/5/96	1	24.0	60	45.6	25.6	0.56	GAC2							BQL	BQL	BQL	BQL	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	INF1	09:23		7.2	13	429		266	305	19.2	655	1.05	1.3	11.1	BQL	43	BQL	BQL	BQL	BQL	5.6	BQL	3.9
11/6/96	1	24.0	60	45.9	26.8	0.58	INF1							278	314	19.8	680	1.05	1.3	11.2	BQL	44.7	BQL	BQL	BQL	BQL	6.5	BQL	4.3
11/6/96	1	24.0	60	45.9	26.8	0.58	INF1	14:31		7.0	14	431		290	317	20	696	1	1.1	8.3	BQL	48.3	BQL	BQL	BQL	BQL	7.9	BQL	3.6
11/6/96	1	24.0	60	45.9	26.8	0.58	INF1							258	294	19.3	637	1	1.2	10.7	BQL	43.9	BQL	BQL	BQL	BQL	6	BQL	3.5
11/6/96	1	24.0	60	45.9	26.8	0.58	INF1							284	314	19.6	682	0.987	0.9	7.7	BQL	46	BQL	BQL	BQL	BQL	5.1	BQL	4.2
11/6/96	1	24.0	60	45.9	26.8	0.58	C1/0	08:59	0.2	7.3	15	416	27	63.7	145	7.3	220	1.22	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	4.2	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C1/0	11:37	0.3																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C1/0	14:13	0.3	7.1	16	577	25																

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (µg/L)	TNB (µg/L)	RDX (µg/L)	Total Nitrobodies (µg/L)	Nitrate (mg/L N)	1,3-Dinitrobenzene (µg/L)	2,4-Dinitrotoluene (µg/L)	2,6-Dinitrotoluene (µg/L)	2-Amino-4,6-dinitrotoluene (µg/L)	2-Nitrotoluene (µg/L)	3-Nitrotoluene (µg/L)	4-Amino-2,6-dinitrotoluene (µg/L)	4-Nitrotoluene (µg/L)	HMX (µg/L)	Nitrobenzene (µg/L)	Tetryl (µg/L)
11/6/96	1	24.0	60	45.9	26.8	0.58	C1/0	16:26	0.3																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C2/0	08:53	0.5	7.4	12	912	27	15.2	81.5	2.1	101	1.3	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.1	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C2/0	11:33	0.7																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C2/0	14:06	0.5	7.3	14	926	24																
11/6/96	1	24.0	60	45.9	26.8	0.58	C2/0	16:23	0.8																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C3/0	08:46	0.6	7.5	12	925	26	3	27.9	0.6	32.8	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C3/0	11:30	0.7																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C3/0	13:59	0.5	7.4	14	938	26																
11/6/96	1	24.0	60	45.9	26.8	0.58	C3/0	16:22	0.7																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C4/0	08:37	0.7	7.7	11	942	25	0.5	10.6	BQL	11.1	1.4	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C4/0	11:27	0.8																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C4/0	13:50	0.5	7.5	15	930	25																
11/6/96	1	24.0	60	45.9	26.8	0.58	C4/0	16:20	0.8																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C5/0	08:30	0.7	7.8	11	935	25	BQL	4.3	BQL	4.3	1.45	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C5/0	11:23	0.8																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C5/0	13:42	0.5	7.6	16	925	25																
11/6/96	1	24.0	60	45.9	26.8	0.58	C5/0	16:18	0.7																				
11/6/96	1	24.0	60	45.9	26.8	0.58	C6/0	08:22	0.5	7.9	11	886	25	BQL	1.7	BQL	1.7	1.53	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C6/0	11:20	0.5					BQL	1.8	BQL	1.8	1.56	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C6/0	13:24	0.4	7.8	15	886	26	BQL	2.1	BQL	2.1	1.52	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	C6/0	16:16	0.4					BQL	2.4	BQL	2.4	1.46	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/6/96	1	24.0	60	45.9	26.8	0.58	GAC3	08:08	0.0	8.0	11	242		BQL	BQL	BQL	BQL	2.09	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	INF1	15:38		6.8	14	427		236	270	17.4	582	0.92	0.9	10.8	BQL	37.6	BQL	BQL	BQL	BQL	5.9	BQL	3.7
11/7/96	1	24.0	60	46.4	25.0	0.54	INF1							270	313	20	673	0.918	1.3	11.5	BQL	45.7	BQL	BQL	BQL	BQL	6.4	BQL	4.8
11/7/96	1	24.0	60	46.4	25.0	0.54	INF1							248	288	18.5	613	0.942	1.1	10.3	BQL	40.5	BQL	BQL	BQL	BQL	2.8	BQL	3.7
11/7/96	1	24.0	60	46.4	25.0	0.54	INF1							235	276	18	583	0.935	1.1	10.5	BQL	36.1	BQL	BQL	BQL	BQL	3.3	BQL	2.6
11/7/96	1	24.0	60	46.4	25.0	0.54	INF1							257	297	18.5	630	0.911	1.2	11.6	BQL	37.2	BQL	BQL	BQL	BQL	4	BQL	3.5
11/7/96	1	24.0	60	46.4	25.0	0.54	C1/0	15:28	0.5	6.9	14	573	25	52.4	122	5.7	184	1.14	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.6	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C1/0	16:28	0.3																				
11/7/96	1	24.0	60	46.4	25.0	0.54	C2/0	15:06	0.5	7.0	14	919	25	11.4	59.8	1.6	74.8	1.23	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C2/0	16:25	0.5																				
11/7/96	1	24.0	60	46.4	25.0	0.54	C3/0	15:00	0.7	7.2	14	945	25	2.7	25.7	0.5	30	1.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.1	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C3/0	16:22	0.9																				
11/7/96	1	24.0	60	46.4	25.0	0.54	C4/0	14:43	0.4	7.4	16	915	25	0.5	9.7	BQL	10.2	1.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C4/0	16:19	0.8																				
11/7/96	1	24.0	60	46.4	25.0	0.54	C5/0	14:37	0.6	7.5	14	919	25	BQL	4.5	BQL	4.5	1.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C5/0	16:16	0.7																				
11/7/96	1	24.0	60	46.4	25.0	0.54	C6/0	14:22	0.3	7.6	14	735	25	BQL	6.2	BQL	6.2	1.5	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C6/0	16:13	0.2					BQL	2.2	BQL	2.2	1.51	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C6/0							BQL	2.2	BQL	2.2	1.37	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	C6/0							BQL	2	BQL	2	1.67	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/7/96	1	24.0	60	46.4	25.0	0.54	GAC3	14:05	0.0	7.6	11	250		BQL	BQL	BQL	BQL	1.98	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	INF1	08:30		6.6	12	429		269	314	17.6	663	0.873	0.9	11.3	BQL	42.2	BQL	BQL	BQL	BQL	5.3	BQL	2.8

PEROXONE Plant Demonstration Task Test Conditions and Results

Demonstration Phase 2

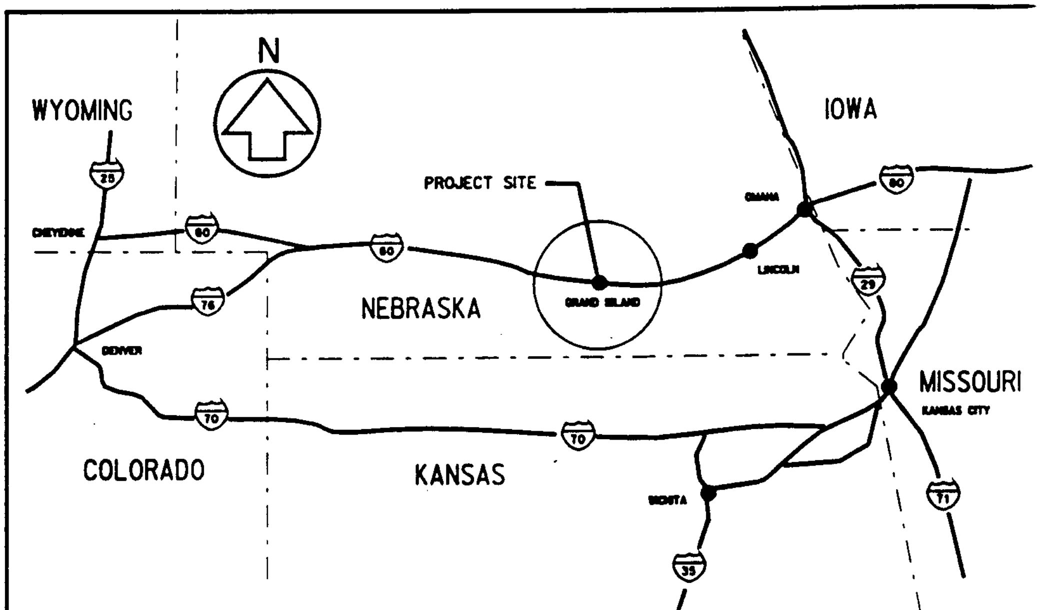
Date	Well	Process Flow Rate (gpm)	Average Applied Ozone Dose (mg/L)	Average Transferred Ozone Dose (mg/L)	Average Hydrogen Peroxide Dose (mg/L)	Average PEROXONE Ratio	Sample Location	Operations Sample Time	Ozone Residual (mg/L)	pH	Temp. of ORP Sample (°C)	Oxidation Reduction Potential (mV)	Contactor Measured Peroxide (mg/L)	TNT (μg/L)	TNB (μg/L)	RDX (μg/L)	Total Nitrobodies (μg/L)	Nitrate (mg/L N	1,3-Dinitro-benzene (μg/L)	2,4-Dinitro-toluene (μg/L)	2,6-Dinitro-toluene (μg/L)	2-Amino-4,6-dinitrotoluene (μg/L)	2-Nitro-toluene (μg/L)	3-Nitro-toluene (μg/L)	4-Amino-2,6-dinitrotoluene (μg/L)	4-Nitro-toluene (μg/L)	HMX (μg/L)	Nitro-benzene (μg/L)	Tetryl (μg/L)
11/8/96	1	24.0	60	45.6	25.0	0.55	INF1							222	323	14.4	608	0.858	0.6	9.5	BQL	31.3	BQL	BQL	BQL	BQL	4.7	BQL	2.8
11/8/96	1	24.0	60	45.6	25.0	0.55	INF1							228	270	16.7	570	0.84	1	10.5	BQL	37.5	BQL	BQL	BQL	BQL	4	BQL	2.4
11/8/96	1	24.0	60	45.6	25.0	0.55	INF1							235	280	18.5	594	0.875	1.1	11.2	BQL	39.8	BQL	BQL	BQL	BQL	5.3	BQL	2.9
11/8/96	1	24.0	60	45.6	25.0	0.55	INF1							232	278	17.2	586	0.827	1	10.6	BQL	38	BQL	BQL	BQL	BQL	5.7	BQL	3.6
11/8/96	1	24.0	60	45.6	25.0	0.55	C1/0	08:09	0.3	6.9	12	610	23	54.4	130	5.7	194	1.05	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	3.6	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C1/0	09:20	0.4																				
11/8/96	1	24.0	60	45.6	25.0	0.55	C2/0	08:02	0.6	7.0	11	945	25	14	76.4	2.1	94.6	1.17	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	2.1	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C2/0	09:16	0.7																				
11/8/96	1	24.0	60	45.6	25.0	0.55	C3/0	07:53	0.8	7.2	11	956	25	2.2	21.3	0.4	25.2	1.2	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	1.3	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C3/0	09:13	0.8																				
11/8/96	1	24.0	60	45.6	25.0	0.55	C4/0	07:48	1.0	7.3	10	955	25	0.4	8.3	BQL	9.5	1.19	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	0.8	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C4/0	09:08	0.9																				
11/8/96	1	24.0	60	45.6	25.0	0.55	C5/0	07:43	0.8	7.4	10	945	25	BQL	3.7	BQL	3.7	1.27	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C5/0	09:05	1.1																				
11/8/96	1	24.0	60	45.6	25.0	0.55	C6/0	07:29	0.5	7.5	10	900	26	BQL	1.5	BQL	1.5	1.28	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C6/0	08:58	0.4					BQL	1.6	BQL	1.6	1.31	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C6/0							BQL	1.5	BQL	1.5	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	C6/0							BQL	1.6	BQL	1.6	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	GAC3	07:18	0.0	7.6	8	253		BQL	BQL	BQL	BQL	1.47	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	GAC1							BQL	BQL	BQL	BQL	1.36	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL
11/8/96	1	24.0	60	45.6	25.0	0.55	GAC2							BQL	BQL	BQL	BQL	1.25	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL	BQL

Appendix D

Peroxone System As-Built Drawings

TRW SPACE &
REDONDO

PEROXONE DEM
CORNHUSKER AR



VICINITY MAP

LIST OF DRAWINGS

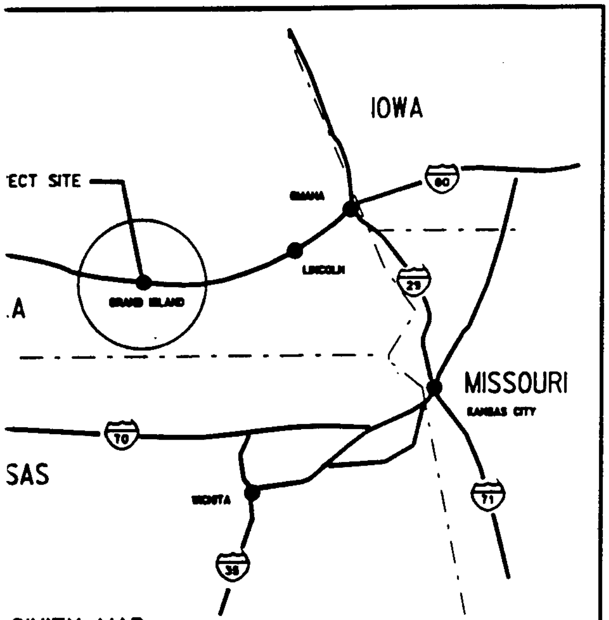
G-1	TITLE SHEET AND AREA MAPS
G-2	ABBREVIATIONS AND SYMBOLS
C-1	GENERAL SITE PLAN
M-1	FACILITY PLAN
M-2	EQUIPMENT SCHEDULE AND DETAILS
S-1	STRUCTURAL PLAN, SECTIONS AND DETAILS
I-1	PROCESS & INSTRUMENTATION DIAGRAM
E-1	ELECTRICAL SCHEMATIC
E-2	PANEL LAYOUTS

24-OCT-1997 14:18

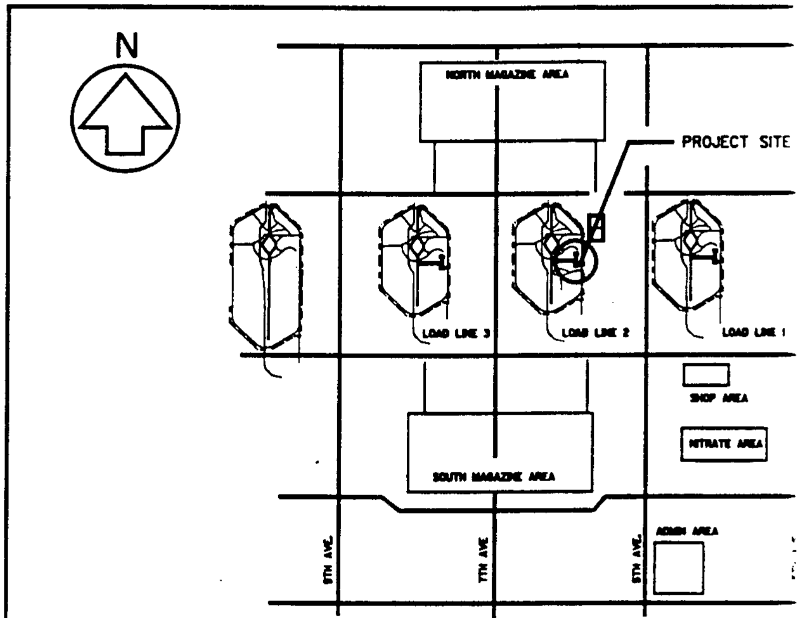
4	3	2

TRW SPACE & TECHNOLOGY DIVISION
REDONDO BEACH, CALIFORNIA

'EROXONE DEMONSTRATION PROGRAM
'RNHUSKER ARMY AMMUNITION PLANT



'CINITY MAP



AREA MAP

AREA MAPS
ND SYMBOLS
AN

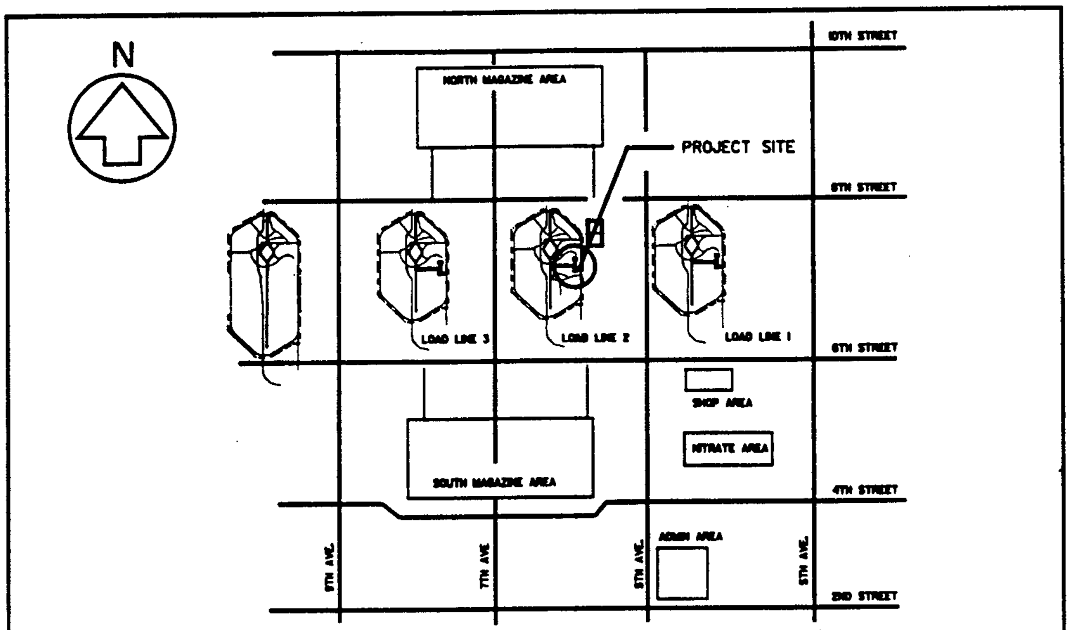
ULE AND DETAILS
, SECTIONS AND DETAILS
JMENTATION DIAGRAM
MATIC

2

4	3	2

:CHNOLOGY DIVISION
CH, CALIFORNIA

;TRATION PROGRAM
AMMUNITION PLANT



AREA MAP

AS BUILT
DATE: 10/24/97

Symbol	Description	Date	Approved
1	AS BUILT – [illegible]	[illegible]	[illegible]
2	AS BUILT FINAL – [illegible] 10/24/97	[illegible]	[illegible]

MONTGOMERY WATSON

THE SPACE & TECHNOLOGY DIVISION

PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT

TITLE SHEET AND AREA MAPS

Designed by: G. TEY

Drawn by: G. TEY

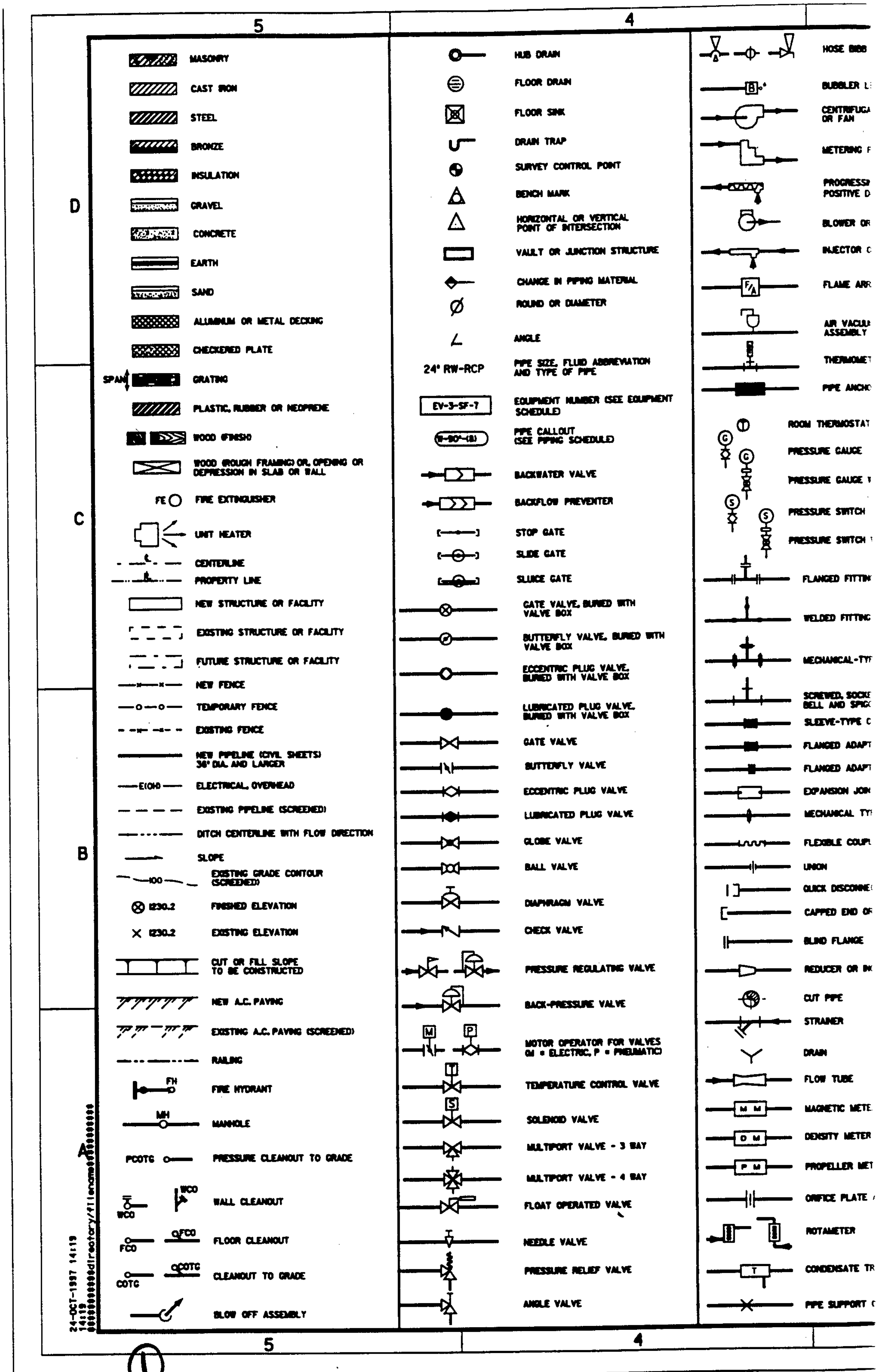
Checked by: R. B. CHANG

Scale: NONE

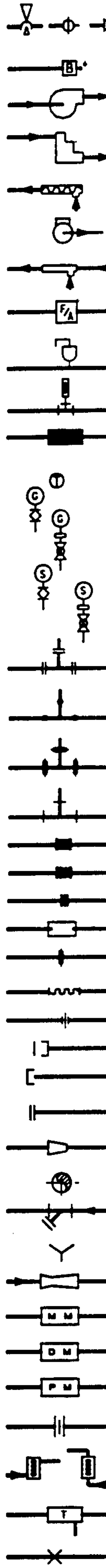
Submitted by: MONTGOMERY WATSON

G-1

3


5
4
D
C
B
A
MASONRY
CAST IRON
STEEL
BRONZE
INSULATION
GRAVEL
CONCRETE
EARTH
SAND
ALUMINUM OR METAL DECKING
CHECKERED PLATE
SPAN
GRATING
PLASTIC, RUBBER OR NEOPRENE
WOOD (FINISH)
WOOD (ROUGH FRAMING) OR, OPENING OR DEPRESSION IN SLAB OR WALL
FE
FIRE EXTINGUISHER
UNIT HEATER
CENTERLINE
PROPERTY LINE
NEW STRUCTURE OR FACILITY
EXISTING STRUCTURE OR FACILITY
FUTURE STRUCTURE OR FACILITY
NEW FENCE
TEMPORARY FENCE
EXISTING FENCE
NEW PIPELINE (CIVIL SHEETS) 36" DIA. AND LARGER
E(OH)
ELECTRICAL, OVERHEAD
EXISTING PIPELINE (SCREENED)
DITCH CENTERLINE WITH FLOW DIRECTION
SLOPE
100
EXISTING GRADE CONTOUR (SCREENED)
1230.2
FINISHED ELEVATION
1230.2
EXISTING ELEVATION
CUT OR FILL SLOPE TO BE CONSTRUCTED
NEW A.C. PAVING
EXISTING A.C. PAVING (SCREENED)
RAILING
FH
FIRE HYDRANT
MH
MANHOLE
PCOTG
PRESSURE CLEANOUT TO GRADE
WCO
WCO
WALL CLEANOUT
FCO
FCO
FLOOR CLEANOUT
COTG
COTG
CLEANOUT TO GRADE
BLOW OFF ASSEMBLY
HUB DRAIN
FLOOR DRAIN
FLOOR SINK
DRAIN TRAP
SURVEY CONTROL POINT
BENCH MARK
HORIZONTAL OR VERTICAL POINT OF INTERSECTION
VAULT OR JUNCTION STRUCTURE
CHANGE IN PIPING MATERIAL
ROUND OR DIAMETER
ANGLE
24" RW-RCP
PIPE SIZE, FLUID ABBREVIATION AND TYPE OF PIPE
EV-3-SF-7
EQUIPMENT NUMBER (SEE EQUIPMENT SCHEDULE)
PIPE CALLOUT (SEE PIPING SCHEDULE)
BACKWATER VALVE
BACKFLOW PREVENTER
STOP GATE
SLIDE GATE
SLUICE GATE
GATE VALVE, BURIED WITH VALVE BOX
BUTTERFLY VALVE, BURIED WITH VALVE BOX
ECCENTRIC PLUG VALVE, BURIED WITH VALVE BOX
LUBRICATED PLUG VALVE, BURIED WITH VALVE BOX
GATE VALVE
BUTTERFLY VALVE
ECCENTRIC PLUG VALVE
LUBRICATED PLUG VALVE
GLOBE VALVE
BALL VALVE
DIAPHRAGM VALVE
CHECK VALVE
PRESSURE REGULATING VALVE
BACK-PRESSURE VALVE
M
P
MOTOR OPERATOR FOR VALVES (M = ELECTRIC, P = PNEUMATIC)
T
TEMPERATURE CONTROL VALVE
S
SOLENOID VALVE
MULTIPORT VALVE - 3 WAY
MULTIPORT VALVE - 4 WAY
FLOAT OPERATED VALVE
NEEDLE VALVE
PRESSURE RELIEF VALVE
ANGLE VALVE
HOSE BIBB
B
BUBBLER L
CENTRIFUGA OR FAN
METERING F
PROGRESSI POSITIVE D
BLOWER OR
INJECTOR C
F/A
FLAME ARR
AIR VACUU ASSEMBLY
THERMOMET
PIPE ANCHO
T
ROOM THERMOSTAT
G
G
PRESSURE GAUGE
PRESSURE GAUGE
S
S
PRESSURE SWITCH
PRESSURE SWITCH
FLANGED FITTIN
WELDED FITTING
MECHANICAL-TYP
SCREWED, SOCKE BELL AND SPIG
SLEEVE-TYPE C
FLANGED ADAPT
FLANGED ADAPT
EXPANSION JOIN
MECHANICAL TY
FLEXIBLE COUPL
UNION
QUICK DISCONNE
CAPPED END OF
BLIND FLANGE
REDUCER OR IN
CUT PIPE
STRAINER
DRAIN
FLOW TUBE
M M
MAGNETIC METE
D M
DENSITY METER
P M
PROPELLER MET
ORIFICE PLATE
ROTAMETER
T
CONDENSATE TR
PIPE SUPPORT
24-OCT-1997 14:19
14:19
5
4

- HUB DRAIN
- FLOOR DRAIN
- FLOOR SINK
- DRAIN TRAP
- SURVEY CONTROL POINT
- BENCH MARK
- HORIZONTAL OR VERTICAL POINT OF INTERSECTION
- VAULT OR JUNCTION STRUCTURE
- CHANGE IN PIPING MATERIAL
- ROUND OR DIAMETER
- ANGLE
- PIPE SIZE, FLUID ABBREVIATION AND TYPE OF PIPE
- EQUIPMENT NUMBER (SEE EQUIPMENT SCHEDULE)
- PIPE CALLOUT (SEE PIPING SCHEDULE)
- BACKWATER VALVE
- BACKFLOW PREVENTER
- STOP GATE
- SLIDE GATE
- SLUICE GATE
- GATE VALVE, BURIED WITH VALVE BOX
- BUTTERFLY VALVE, BURIED WITH VALVE BOX
- ECCENTRIC PLUG VALVE, BURIED WITH VALVE BOX
- LUBRICATED PLUG VALVE, BURIED WITH VALVE BOX
- GATE VALVE
- BUTTERFLY VALVE
- ECCENTRIC PLUG VALVE
- LUBRICATED PLUG VALVE
- GLOBE VALVE
- BALL VALVE
- DIAPHRAGM VALVE
- CHECK VALVE
- PRESSURE REGULATING VALVE
- BACK-PRESSURE VALVE
- MOTOR OPERATOR FOR VALVES (M = ELECTRIC, P = PNEUMATIC)
- TEMPERATURE CONTROL VALVE
- SOLENOID VALVE
- MULTIPORT VALVE - 3 WAY
- MULTIPORT VALVE - 4 WAY
- FLOAT OPERATED VALVE
- NEEDLE VALVE
- PRESSURE RELIEF VALVE
- ANGLE VALVE



- HOSE BIBB (H/B)
- BUBBLER LEVEL CONTROL
- CENTRIFUGAL OR TURBINE PUMP OR FAN
- METERING PUMP
- PROGRESSING CAVITY, POSITIVE DISPLACEMENT PUMP
- BLOWER OR COMPRESSOR
- INJECTOR OR EDUCTOR
- FLAME ARRESTER
- AIR VACUUM AND AIR RELEASE ASSEMBLY
- THERMOMETER
- PIPE ANCHOR
- ROOM THERMOSTAT
- PRESSURE GAUGE
- PRESSURE GAUGE WITH DIAPHRAGM SEAL
- PRESSURE SWITCH
- PRESSURE SWITCH WITH DIAPHRAGM SEAL
- FLANGED FITTING
- WELDED FITTING
- MECHANICAL-TYPE FITTING (GROOVED)
- SCREWED, SOCKET-WELD, BELL AND SPIGOT OR HUBLESS FITTING
- SLEEVE-TYPE COUPLING
- FLANGED ADAPTER COUPLING
- FLANGED ADAPTER - SET SCREW TYPE
- EXPANSION JOINT
- MECHANICAL TYPE COUPLING
- FLEXIBLE COUPLING
- UNION
- QUICK DISCONNECT COUPLER
- CAPPED END OR PLUGGED END
- BLIND FLANGE
- REDUCER OR INCREASER
- CUT PIPE
- STRAINER
- DRAIN
- FLOW TUBE
- MAGNETIC METER
- DENSITY METER
- PROPELLER METER
- ORIFICE PLATE AND FLANGES
- ROTAMETER
- CONDENSATE TRAP
- PIPE SUPPORT (IN PLAN ONLY)

AB	ANCHOR BOLT
ABBR	ABBREVIATION
ABS	ABSOLUTE TEMPERATURE
AC	ACTIVATED CARBON, ASPHALTIC CONCRETE, OR ALTERNATING CURRENT
A/C	AIR CONDITIONING
ACOUS	ACOUSTIC OR ACOUSTICAL
ACP	ASPHALTIC CONCRETE PAVEMENT
ADJ	ADJUSTABLE
AL	ALUMINUM OR ALUM
ALUM	ALUMINUM
AMB	AMBIENT
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE (FORMERLY A.S.A.)
API	AMERICAN PETROLEUM INSTITUTE
APPD	APPROVED
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
ASA	AMERICAN STANDARDS ASSOCIATION(NOW ANSI)
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIAL
ASSY	ASSEMBLY
AT	ACOUSTICAL TILE
ATM	ATMOSPHERE
AVAR	AIR VACUUM AND AIR RELEASE VALVE
AWWA	AMERICAN WATER WORKS ASSOCIATION
BD	BOARD
BF	BLIND FLANGE
BFP	BACK FLOW PREVENTER
BHP	BRAKE HORSEPOWER
BLDG	BUILDING
BLD FLG	BLIND FLANGE
BLK	BLACK OR BLOCK
BLKG	BLOCKING
BM	BEAM OR BENCH MARK
BOT	BOTTOM
B & S	BELL AND SPIGOT
BSMT	BASEMENT
BT	BOLT
BTU	BRITISH THERMAL UNIT
BV	BUTTERFLY VALVE
C	CENTIGRADE
CAP	CAPACITY
CC	CENTER TO CENTER
CFH	CUBIC FEET PER HOUR
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHEM	CHEMICAL
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CHLORINE GAS, CHLORINATOR, CHAIN LINK, CLEARANCE OR CENTERLINE
CLG	CEILING
CLR	CLEAR
CM	CENTIMETER
CML & C	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
CONC	CONCRETE OR CONCENTRIC
COND	CONDENSER OR CONDENSATE
CONN	CONNECTION
CONSTR	CONSTRUCTION OR CONSTRUCT
CONT	CONTINUED OR CONTINUOUS
CONTR	CONTRACTOR
COMP	COMPRESSOR
COTG	CLEAN-OUT TO GRADE
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CAUSTIC SODA OR CAST STEEL
CTR	CENTER
CYL	CYLINDER
DC	DIRECT CURRENT
DET	DETAIL
DF	DRINKING FOUNTAIN OR DOUGLAS FIR
DI	DUCTILE IRON
DIA	DIAMETER
DIAG	DIAGONAL
DIAPH	DIAPHRAGM
DISCH	DISCHARGE
DN	DOWN OR DECANT
DR	DOOR OR DRAIN
DS	DRENCH SHOWER AND EYE WASH
DWG	DRAWING
DIFF	DIFFUSER OR DIFFERENTIAL
E	EAST
EA	EACH
EB	EXPANSION BOLT OR ANCHOR
EC	END CURVE
ECC	ECCENTRIC
EF	EACH FACE OR EXHAUST FAN
EFF	EFFLUENT
EG	EXHAUST GRILLE OR EXISTING GRADE
EL	ELEVATION
ELEC	ELECTRICAL OR ELECTRONIC
ENG	ENGINE
EP	EDGE OF PAVEMENT
ENCL	ENCLOSURE
ENT	ENTRANCE
EQ	EQUAL
EQUIP	EQUIPMENT
EW	EACH WAY OR EYE WASH
EXH	EXHAUST
EX-HY	EXTRA HEAVY
EXIST	EXISTING
EXP JT	EXPANSION JOINT
EXT	EXTERIOR OR EXTENSION
EXTR	EXTRUDED
F	FAHRENHEIT OR FINISH
FABR	FABRICATION, FABRICATE OR FABRICATED
FB	FLAT BAR, FLOOR BEAM OR FIELD BOOK
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FE	FIRE EXTINGUISHER OR FINAL EFFLUENT
FEM	FEMALE (PIPE THREAD)
FF	FLAT FACE OR FAR FACE
F TO F	FACE TO FACE
FG	FINISHED GRADE
FH	FIRE HYDRANT
FIG	FIGURE
FIN	FINISHED
FIX	FIXTURE
FL	FLOOR
FLEX	FLEXIBLE
FLG	FLANGE OR FLOORING
FLGD	FLANGED
FLL	FLOW LINE
FLR	FLOOR
FM	FACTORY MUTUAL (LAB. APPROVED)
FND	FOUNDATION
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FOS	FACE OF STUDS
FOW	FACE OF WALL
FP	EDGE OF PAVEMENT
FPC	FLEXIBLE PIPE COUPLING
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FR	FRAME
FRP	FIBERGLASS REINFORCED PLASTIC
FS	FAR SIDE, FLOOR SINK, FINISHED SURFACE, FORGED STEEL, FROTH SPRAY OF FACTOR OF SAFETY
FSL	LOW FLOW SWITCH
FT	FEET OR FOOT
FT. LB	FOOT-POUND
FTG	FOOTING
FUT	FUTURE
GA	GAGE OR GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERAL OR GENERATOR
GI	GALVANIZED IRON
GL	GLASS
GLV	GLOBE VALVE
GND	GROUND
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GRD	GRADE OR GROUND
GRTG	GRATING
GV	GATE VALVE
GW	GROUNDWATER
GYP	GYPSUM
H/B	HOSE BIBB
HDPE	HIGH DENSITY POLYETHYLENE
HDR	HEADER
HDW	HARDWARE
HEX	HEXAGONAL
Hg	MERCURY
HGT	HEIGHT
HORIZ	HORIZONTAL
HP	HORSEPOWER OR HIGH PRESSURE
H/P	HIGH POINT
HR	HEATING RETURN OR HOUR
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HWL	HIGH WATER LEVEL
HWD	HARDWOOD
HWO	HANDWHEEL OPERATED
HYD	HYDRAULIC OR HYDRANT
ID	INSIDE DIAMETER
IF	INSIDE FACE
IN	INCH
INFL	INFLUENT
IN. LB	INCH-POUND
INSL	INSULATION OR INSULATED
INSTR	INSTRUMENT
INT	INTERIOR
INV	INVERT ELEVATION
IP	IRON PIPE
IRRG	IRRIGATION
JT	JOINT
K	KELVIN, KILO OR KARAT
KG	KILOGRAM
KM	KILOMETER
KV	KILOVOLT
KW	KILOWATT
KWH	KILOWATT HOUR
L/P	LOW POINT
L	LITER
LAB	LABORATORY
LAV	LAVATORY
LB	POUND
LEV	LEVEL
LG	LENGTH OR LONG
LOL	LAYOUT LINE
LT	LEFT OR LIGHT
LWL	LOW WATER LEVEL
LWR	LOWER
M	METER OR MALE (PIPE THREAD)
MAG	MAGNETIC
MACH	MACHINE
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MED	MEDIUM
MFR	MANUFACTURER
MFR'D	MANUFACTURED
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MI	MALLEABLE IRON
MICRON	1/1,000,000 METER
MIL	MILITARY OR 1/1,000 INCH
MIN	MINIMUM OR MINUTE
MISC	MISCELLANEOUS
MK	MARK
MOD	MODEL
MS	MOP SINK
MTC	MECHANICAL-TYPE COUPLING
MTD	MOUNTED
MTG	MOUNTING
MTL	MATERIAL OR METAL
MTR	MOTOR
MX	MIXER
N	NORTH
NBS	NATIONAL BUREAU OF STANDARDS
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NG	NATURAL GRADE OR NATURAL GAS
NIC	NOT IN CONTRACT
NO	NUMBER OR NORMALLY OPEN
NPS	NOMINAL PIPE SIZE (FORMERLY I.P.S.) OR NATIONAL PARK SERVICE
NPT	NATIONAL PIPE THREAD
NRS	NON-RISING STEM
NS	NEAR SIDE
NTS	NOT TO SCALE
OC	OVER-CROSSING OR ON CENTER
OD	OUTSIDE DIAMETER OR OVERALL DIMENSION
OF	OVERFLOW OR OUTSIDE FACE
OH	OVER HEAD
OPER	OPERATOR OR OPERATING
OPNG	OPENING
ORIG	ORIGINAL
OZ	OUNCE
PG	PRESSURE GAGE
pH	HYDROGEN ION CONCENTRATION
PI	POINT OF INTERSECTION
PL	PLATE, PROPERTY LINE OR PLACE
PNEU	PNEUMATIC
POT	POINT OF TANGENT
PP	POWER POLE OR POLYPROPYLENE
PPD	POUNDS PER DAY
PPH	POUNDS PER HOUR
PPM	PARTS PER MILLION
PREFAB	PREFABRICATED
PRESS	PRESSURE
PRV	PRESSURE REGULATING, RELIEF OR REDUCING VALVE

2 | 1

ANCHOR BOLT
BR ABBREVIATION
S ABSOLUTE TEMPERATURE
ACTIVATED CARBON, ASPHALTIC CONCRETE, OR ALTERNATING CURRENT
C AIR CONDITIONING
OUS ACOUSTIC OR ACOUSTICAL
P ASPHALTIC CONCRETE PAVEMENT
J ADJUSTABLE

ALUMINUM OR ALUM
UM ALUMINUM
B AMBIENT
SI AMERICAN NATIONAL STANDARDS INSTITUTE (FORMERLY A.S.A.)
AMERICAN PETROLEUM INSTITUTE
PD APPROVED
PROX APPROXIMATE
CH ARCHITECTURAL
A AMERICAN STANDARDS ASSOCIATIONNOW ANSI
ME AMERICAN SOCIETY OF MECHANICAL ENGINEERS
TM AMERICAN SOCIETY FOR TESTING AND MATERIAL
SY ASSEMBLY
ACOUSTICAL TILE
M ATMOSPHERE
AR AIR VACUUM AND AIR RELEASE VALVE
WA AMERICAN WATER WORKS ASSOCIATION

BOARD
BLIND FLANGE
P BACK FLOW PREVENTER
P BRAKE HORSEPOWER
DG BUILDING
D FLG BLIND FLANGE
K BLACK OR BLOCK
KG BLOCKING
BEAM OR BENCH MARK
T BOTTOM
& S BELL AND SPIGOT
MT BASEMENT
BOLT
U BRITISH THERMAL UNIT
BUTTERFLY VALVE

CENTIGRADE
P CAPACITY
CENTER TO CENTER
H CUBIC FEET PER HOUR
M CUBIC FEET PER MINUTE
S CUBIC FEET PER SECOND
EM CHEMICAL
CAST IRON
CONSTRUCTION JOINT
CHLORINE GAS, CHLORINATOR, CHAIN LINK,
CLEARANCE OR CENTERLINE
G CEILING
R CLEAR

CENTIMETER
L & C CEMENT MORTAR LINED AND COATED
CORRUGATED METAL PIPE
U CONCRETE MASONRY UNIT
CLEANOUT
L COLUMN
NC CONCRETE OR CONCENTRIC
ND CONDENSER OR CONDENSATE
NN CONNECTION
NSTR CONSTRUCTION OR CONSTRUCT
NT CONTINUED OR CONTINUOUS
NTR CONTRACTOR
MP COMPRESSOR
TC CLEAN-OUT TO GRADE
LG COUPLING
VC CHLORINATED POLYVINYL CHLORIDE
CAUSTIC SODA OR CAST STEEL
R CENTER
L CYLINDER

DIRECT CURRENT
T DETAIL
DRINKING FOUNTAIN OR DOUGLAS FIR
DUCTILE IRON
DIAMETER
G DIAGONAL
PH DIAPHRAGM
CH DISCHARGE
DOWN OR DECANT
DOOR OR DRAIN
DRENCH SHOWER AND EYE WASH
G DRAWING
F DIFFUSER OR DIFFERENTIAL

EAST
EACH
EXPANSION BOLT OR ANCHOR
END CURVE
ECCENTRIC
EACH FACE OR EXHAUST FAN
EFFLUENT
EXHAUST GRILLE OR EXISTING GRADE
ELEVATION
EC ELECTRICAL OR ELECTRONIC
ENGINE
EDGE OF PAVEMENT
CL ENCLOSURE
T ENTRANCE
EQUAL
UIP EQUIPMENT
H EACH WAY OR EYE WASH
EXHAUST
HY EXTRA HEAVY
IST EXISTING
P JT EXPANSION JOINT
T EXTERIOR OR EXTENSION
TR EXTRUDED

FAHRENHEIT OR FINISH
BR FABRICATION, FABRICATE OR FABRICATED
FLAT BAR, FLOOR BEAM OR FIELD BOOK
O FLOOR CLEANOUT
FLOOR DRAIN
FIRE EXTINGUISHER OR FINAL EFFLUENT
M FEMALE (PIPE THREAD)
FLAT FACE OR FAR FACE
TO F FACE TO FACE
FINISHED GRADE
FIRE HYDRANT
FIGURE
FINISHED
FIXTURE
FLOOR
EX FLEXIBLE
FLANGE OR FLOORING
GD FLANGED
FLOW LINE
R FLOOR
FACTORY MUTUAL (LAB. APPROVED)
FOUNDATION
FACE OF CONCRETE
FACE OF MASONRY
FACE OF STUDS
FACE OF WALL
EDGE OF PAVEMENT

FPC FLEXIBLE PIPE COUPLING
FPM FEET PER MINUTE
FPS FEET PER SECOND
FR FRAME
FRP FIBERGLASS REINFORCED PLASTIC
FS FAR SIDE, FLOOR SINK, FINISHED SURFACE, FORGED STEEL, FROTH SPRAY OF FACTOR OF SAFETY
FSL LOW FLOW SWITCH
FT FEET OR FOOT
FT.LB FOOT-POUND
FTG FOOTING
FUT FUTURE

GA GAGE OR GAUGE
GAL GALLON
GALV GALVANIZED
GEN GENERAL OR GENERATOR
GI GALVANIZED IRON
GL GLASS
GLV GLOBE VALVE
GND GROUND
GPD GALLONS PER DAY
GPH GALLONS PER HOUR
GPM GALLONS PER MINUTE
GRD GRADE OR GROUND
GRTG GRATING
GV GATE VALVE
GW GROUNDWATER
GYP GYPSUM

H/B HOSE BIBB
HDPE HIGH DENSITY POLYETHYLENE
HDR HEADER
HDW HARDWARE
HEX HEXAGONAL
Hg MERCURY
HGT HEIGHT
HORIZ HORIZONTAL
HP HORSEPOWER OR HIGH PRESSURE
H/P HIGH POINT
HR HEATING RETURN OR HOUR
HVAC HEATING, VENTILATING AND AIR CONDITIONING
HWL HIGH WATER LEVEL
HWD HARDWOOD
HWO HANDWHEEL OPERATED
HYD HYDRAULIC OR HYDRANT
ID INSIDE DIAMETER
IF INSIDE FACE
IN INCH
INFL INFLUENT
IN.LB INCH-POUND
INSL INSULATION OR INSULATED
INSTR INSTRUMENT
INT INTERIOR
INV INVERT ELEVATION
IP IRON PIPE
IRRIG IRRIGATION
JT JOINT
K KELVIN, KILO OR KARAT
KG KILOGRAM
KM KILOMETER
KV KILOVOLT
KW KILOWATT
KWH KILOWATT HOUR

L/P LOW POINT
L LITER
LAB LABORATORY
LAV LAVATORY
LB POUND
LEV LEVEL
LG LENGTH OR LONG
LOL LAYOUT LINE
LT LEFT OR LIGHT
LWL LOW WATER LEVEL
LWR LOWER

M METER OR MALE (PIPE THREAD)
MAG MAGNETIC
MACH MACHINE
MAX MAXIMUM
MCC MOTOR CONTROL CENTER
MECH MECHANICAL
MED MEDIUM
MFR MANUFACTURER
MFR'D MANUFACTURED
MGD MILLION GALLONS PER DAY
MH MANHOLE
MI MALLEABLE IRON
MICRON 1/1,000,000 METER
MIL MILITARY OR 1/1,000 INCH
MIN MINIMUM OR MINUTE
MISC MISCELLANEOUS
MK MARK
MOD MODEL
MS MOP SINK
MTC MECHANICAL-TYPE COUPLING
MTD MOUNTED
MTG MOUNTING
MTL MATERIAL OR METAL
MTR MOTOR
MX MIXER

N NORTH
NBS NATIONAL BUREAU OF STANDARDS
NC NORMALLY CLOSED
NEC NATIONAL ELECTRICAL CODE
NEMA NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA NATIONAL FIRE PROTECTION ASSOCIATION
NG NATURAL GRADE OR NATURAL GAS
NIC NOT IN CONTRACT
NO NUMBER OR NORMALLY OPEN
NPS NOMINAL PIPE SIZE (FORMERLY I.P.S.) OR NATIONAL PARK SERVICE
NPT NATIONAL PIPE THREAD
NRS NON-RISING STEM
NS NEAR SIDE
NTS NOT TO SCALE

OC OVER-CROSSING OR ON CENTER
OD OUTSIDE DIAMETER OR OVERALL DIMENSION
OF OVERFLOW OR OUTSIDE FACE
OH OVER HEAD
OPER OPERATOR OR OPERATING
OPNG OPENING
ORIG ORIGINAL
OZ OUNCE

PG PRESSURE GAGE
pH HYDROGEN ION CONCENTRATION
PI POINT OF INTERSECTION
PL PLATE, PROPERTY LINE OR PLACE
PNEU PNEUMATIC
POT POINT OF TANGENT
PP POWER POLE OR POLYPROPYLENE
PPD POUNDS PER DAY
PPH POUNDS PER HOUR
PPM PARTS PER MILLION
PREFAB PREFABRICATED
PRESS PRESSURE
PRV PRESSURE REGULATING, RELIEF OR REDUCING VALVE

PS PRESSURE SWITCH
PSF POUNDS PER SQUARE FOOT
PSI POUNDS PER SQUARE INCH
PSIA POUNDS PER SQUARE INCH ABSOLUTE
PSIG POUNDS PER SQUARE INCH GAUGE
PT POINT OF TANGENT
PTDF PRESSURE TREATED DOUGLAS FIR
PTFE POLYTETRAFLUOROETHYLENE (TEFLON®)
PV PLUG VALVE
PVC POLYVINYL CHLORIDE
PVDF POLYVINYLIDENE FLUORIDE (KYNAR®)
QT QUARRY TILE
QTY QUANTITY

R RADIUS, RISER, RETURN OR RATE OF SLOPE
RAD RADIUS
RCP REINFORCED CONCRETE PIPE
RD ROOF DRAIN, ROUND, OR ROAD

RECIRC RECIRCULATED
RED REDUCER OR REDUCING
REF REFERENCE OR REFER
REG REGULATING
REIN REINFORCE OR REINFORCED
REQD REQUIRED
RESL RESILIENT
REV REVISION
RFG ROOFING
RF ROOF OR RAISED FACE
RM ROOM
RPM REVOLUTIONS PER MINUTE
RT RIGHT
RTP REINFORCED THERMOSETTING PLASTIC
R/W RIGHT OF WAY
RWL RAINWATER LEADER

S SOUTH, SCUM, SINK, SECOND OR SLOPE
SA SAMPLE
SCD SCREWED
SCFM STANDARD CUBIC FEET PER MINUTE
SCH SCHEDULE
SDR STORM DRAINS
SEC SECONDARY
SECT SECTION
SHT SHEET OR SHELF
SIM SIMILAR
SL SLUDGE OR SLOPE
SOLN SOLUTION
SP STATIC PRESSURE
SPECS SPECIFICATIONS
SPECF SPECIFIED
SQ SQUARE
SS SANITARY SEWER, STAINLESS STEEL OR SERVICE SINK
SSU SECONDS SAYBOLT UNIVERSAL
STA STATION
STC SLEEVE-TYPE COUPLING
STD STANDARD
STL STEEL
STM STEAM
STN STAINLESS
SST STAINLESS STEEL
STRUCT STRUCTURAL OR STRUCTURE
SUCT SUCTION
SV SOLENOID VALVE
SYM SYMMETRICAL OR SYMBOL
SYS SYSTEM

TAN TANGENT
T & B TOP AND BOTTOM
TC TOP OF CURB
TEMP TEMPERATURE OR TEMPORARY
THK THICK OR THICKNESS
TK TANK
TP TELEPHONE POLE OR TELEGRAPH POLE
TRANS TRANSITION OR TRANSMITTER
TW TOP OF WALL OR THERMOMETER WELL
TYP TYPICAL

UB UNION BONNET
UC UNDER-CROSSING
UG UNDERGROUND
UGC UNDERGROUND CONDUIT
UH UNIT HEATER
UL UNDERWRITERS LABORATORIES

V VACUUM, VALVE, VERTICAL, VENT, VOLT OR VOLUME
VAR VARIES OR VARIABLE
VCP VITRIFIED CLAY PIPE
VERT VERTICAL
VOL VOLUME
VTC VENT TO CEILING
VTR VENT THROUGH ROOF

W WEST OR WASTE
W/ WITH
WCO WALL CLEANOUT
WH WATER HEATER
WI WROUGHT IRON
W/O WITHOUT
WS WATER SURFACE
WSTP WATER STOP
WT WEIGHT
WWP WATER WORKING PRESSURE

XS EXTRA STRONG
XXS DOUBLE EXTRA STRONG

YD YARD
YR YEAR

Z ZERO OR ZONE
ZN ZINC

D
C
B
A

AS BUILT
DATE: 10/24/97

No.	Description	Date	Approved
△	AS BUILT - [illegible] 09/10/97	09/10/97	[illegible]
△	AS BUILT FINAL - [illegible] 10/24/97	10/24/97	[illegible]
△			
△			
△			
△			

MONTGOMERY WATSON

TRW SPACE & TECHNOLOGY DIVISION

PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT

ABBREVIATIONS AND SYMBOLS

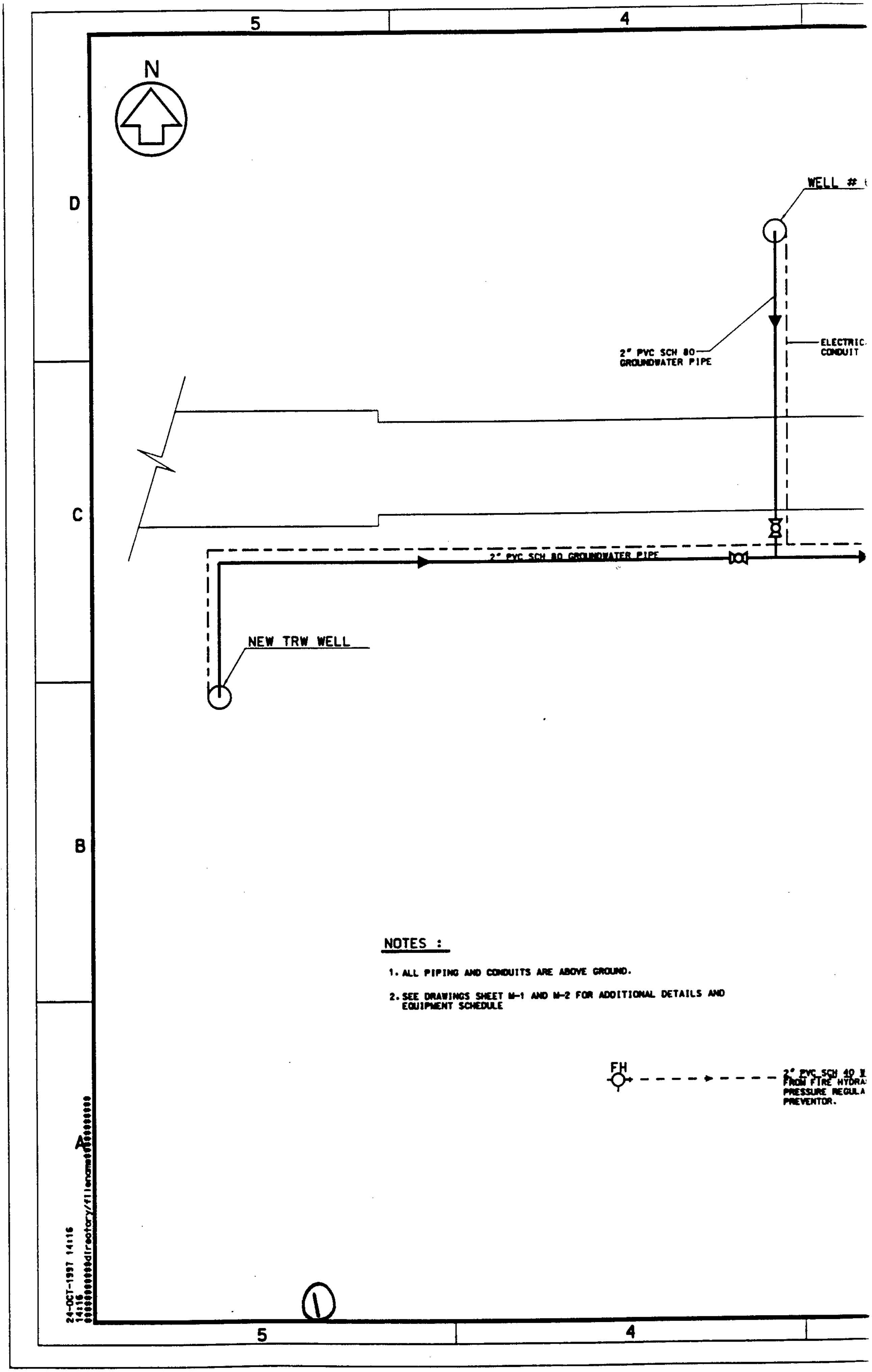
Designed by: G. TEY
Drawn by: G. TEY
Checked by: R. S. CHANG
Approved by: [illegible] SCHLEDER
Submitted by: MONTGOMERY WATSON

Scale: NONE

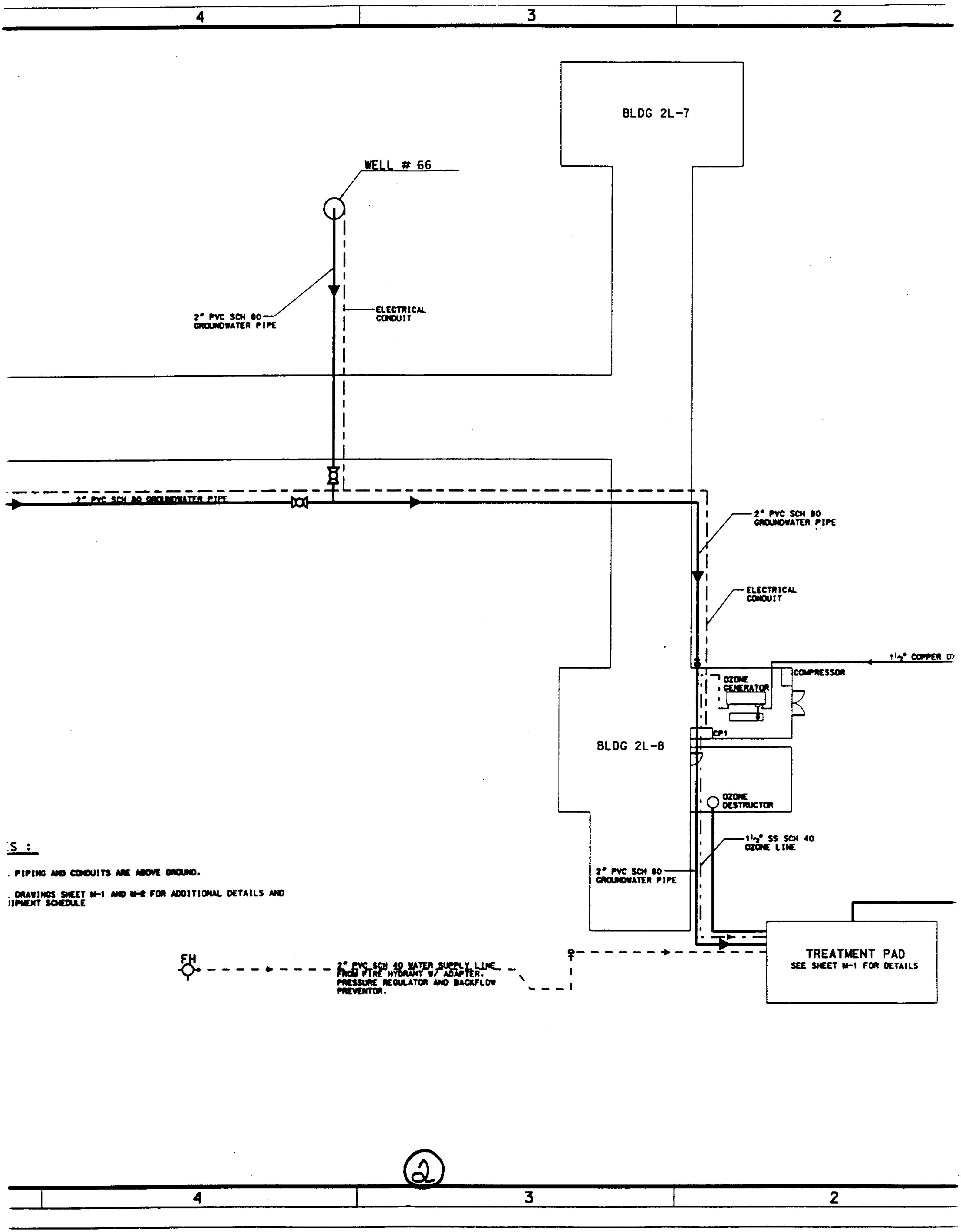
G-2

2 | 1

3

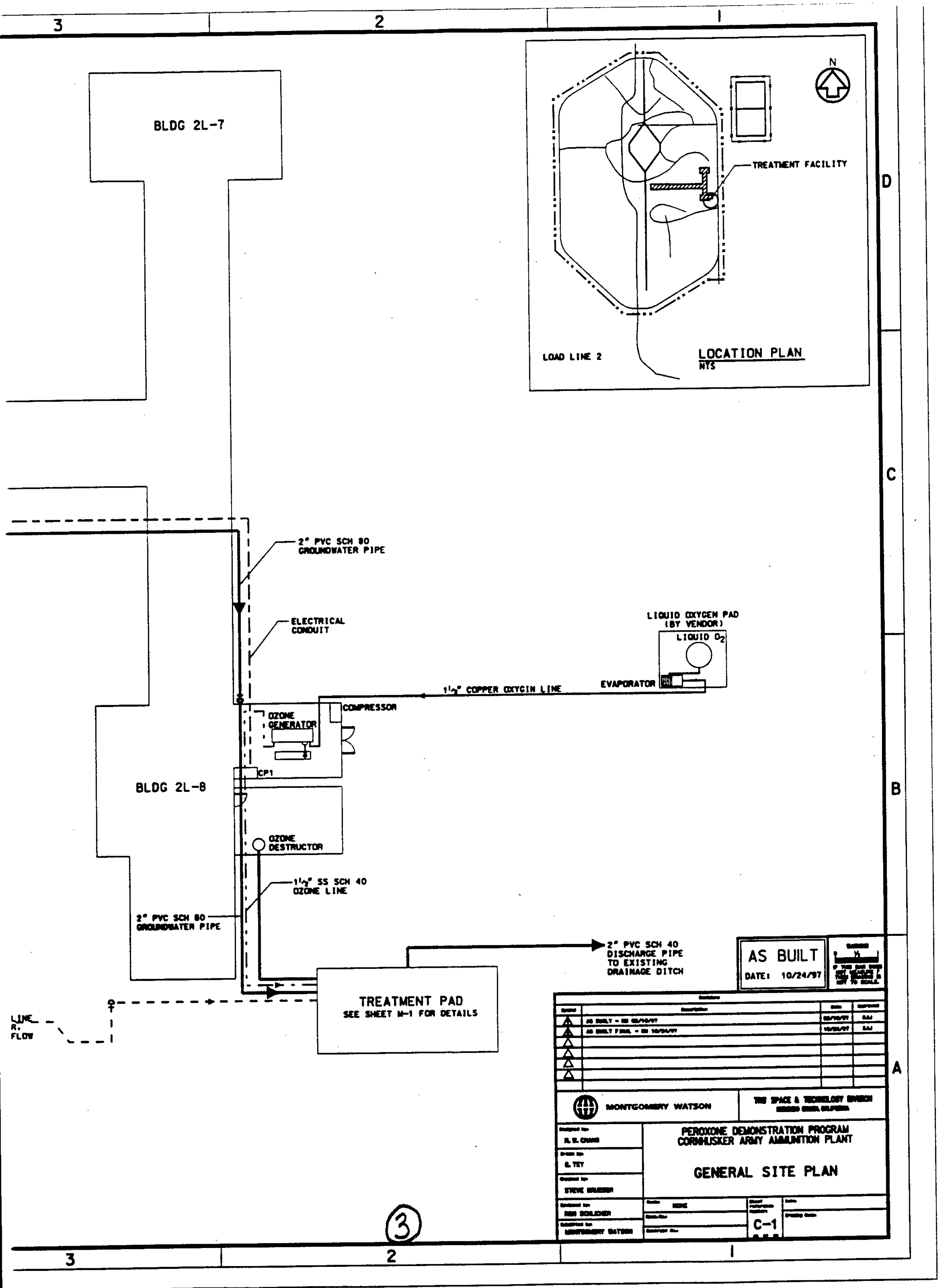


5
4
D
C
B
A
N
WELL #
2" PVC SCH 80
GROUNDWATER PIPE
ELECTRIC
CONDUIT
2" PVC SCH 80 GROUNDWATER PIPE
NEW TRW WELL
NOTES :
1. ALL PIPING AND CONDUITS ARE ABOVE GROUND.
2. SEE DRAWINGS SHEET M-1 AND M-2 FOR ADDITIONAL DETAILS AND EQUIPMENT SCHEDULE
FH
2" PVC SCH 40
FROM FIRE HYDRA
PRESSURE REGULA
PREVENTOR.
24-OCT-1997 14:16
1

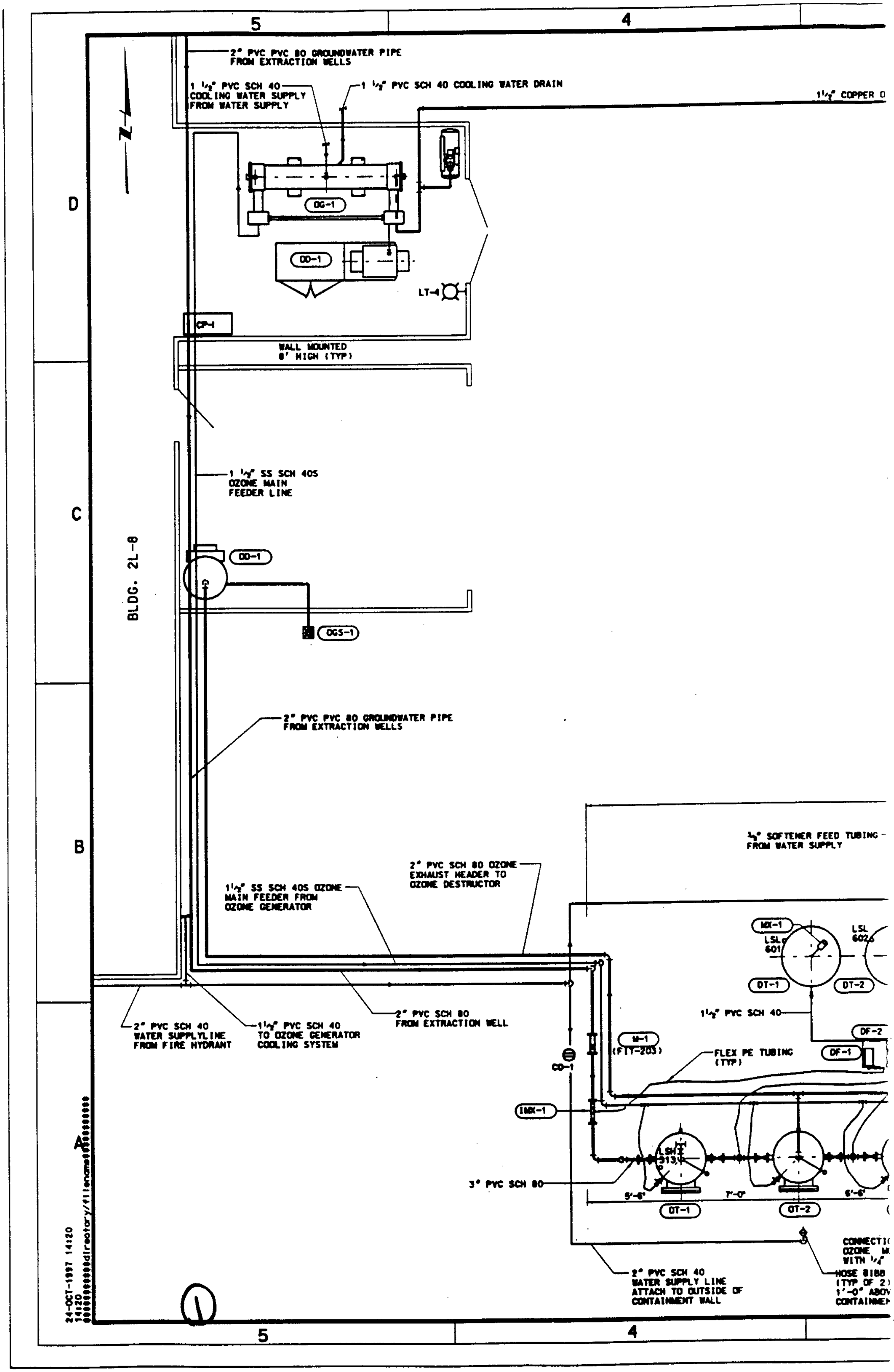


4
3
2
BLDG 2L-7
WELL # 66
2" PVC SCH 80 GROUNDWATER PIPE
ELECTRICAL CONDUIT
2" PVC SCH 80 GROUNDWATER PIPE
2" PVC SCH 80 GROUNDWATER PIPE
ELECTRICAL CONDUIT
1½" COPPER
COMPRESSOR
OZONE GENERATOR
CP1
BLDG 2L-8
OZONE DESTRUCTOR
1½" SS SCH 40 OZONE LINE
2" PVC SCH 80 GROUNDWATER PIPE
S :
. PIPING AND CONDUITS ARE ABOVE GROUND.
. DRAWINGS SHEET M-1 AND M-2 FOR ADDITIONAL DETAILS AND
IPMENT SCHEDULE
FH
2" PVC SCH 40 WATER SUPPLY LINE FROM FIRE HYDRANT W/ ADAPTER. PRESSURE REGULATOR AND BACKFLOW PREVENTOR.
TREATMENT PAD
SEE SHEET M-1 FOR DETAILS
4
3
2

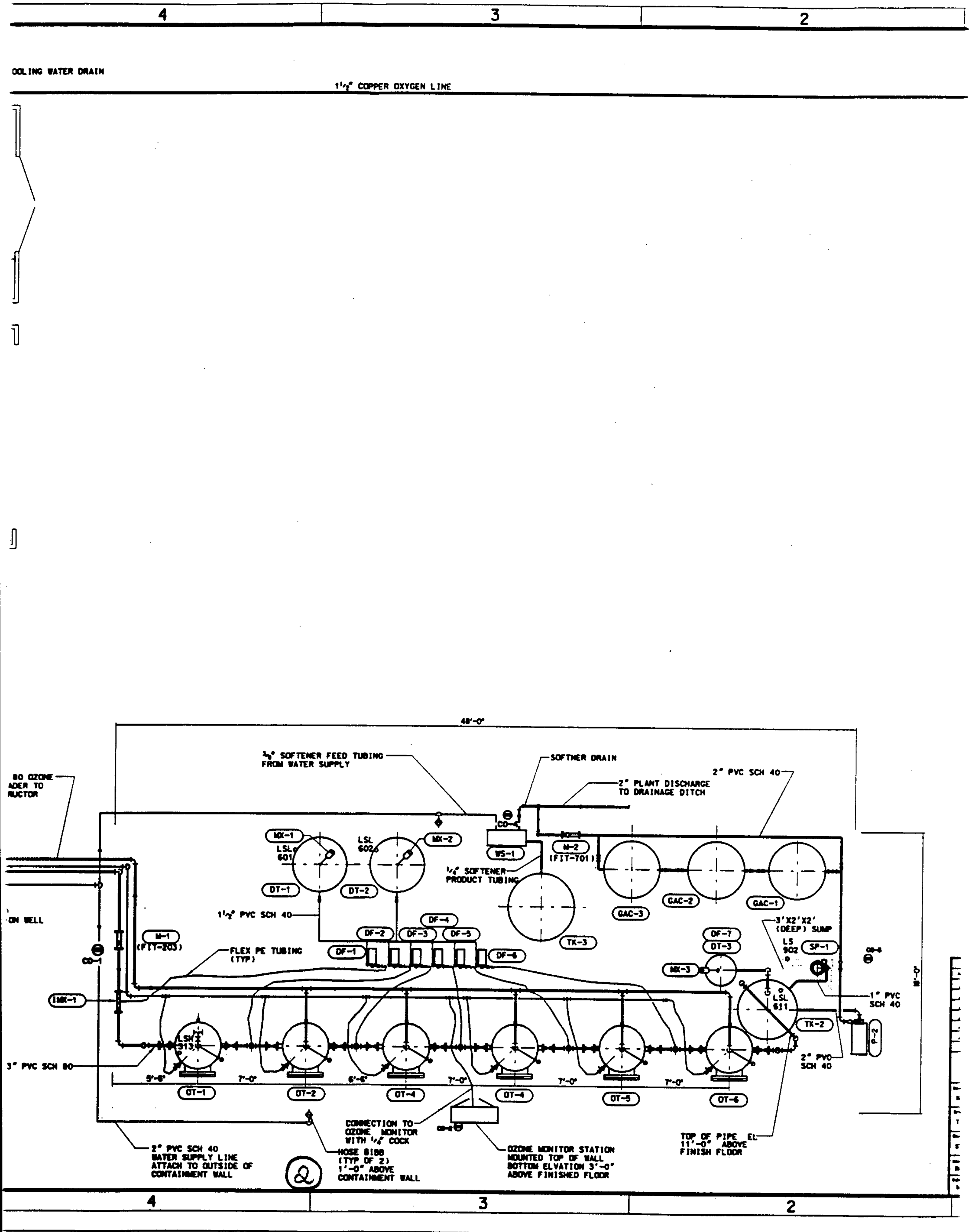
2



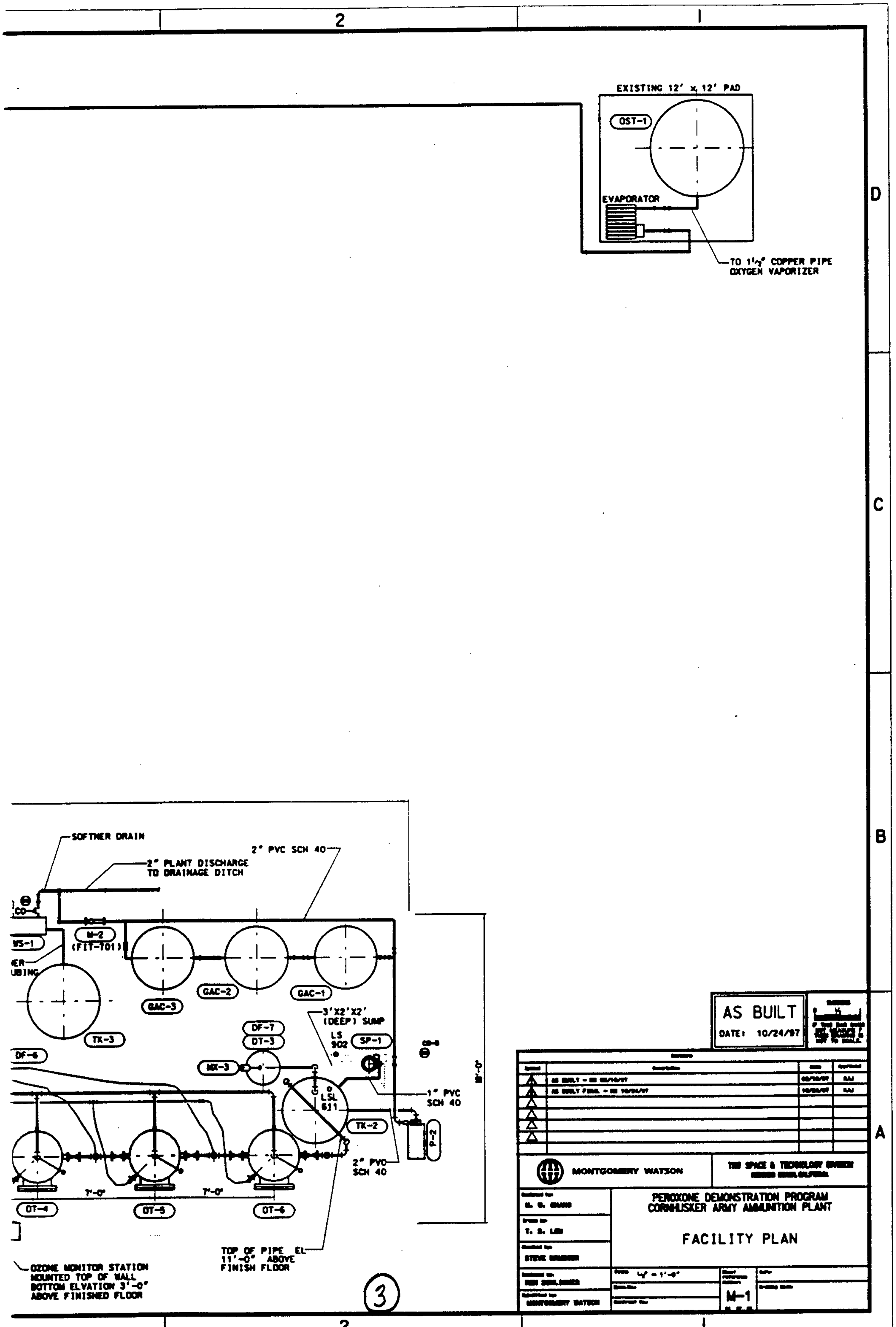
BLDG 2L-7
BLDG 2L-8
TREATMENT FACILITY
LOAD LINE 2
LOCATION PLAN
NTS
N
2" PVC SCH 80
GROUNDWATER PIPE
ELECTRICAL
CONDUIT
LIQUID OXYGEN PAD
(BY VENDOR)
LIQUID O2
EVAPORATOR
1½" COPPER OXYGIN LINE
COMPRESSOR
OZONE
GENERATOR
CP1
OZONE
DESTRUCTOR
1½" SS SCH 40
OZONE LINE
2" PVC SCH 80
GROUNDWATER PIPE
2" PVC SCH 40
DISCHARGE PIPE
TO EXISTING
DRAINAGE DITCH
TREATMENT PAD
SEE SHEET M-1 FOR DETAILS
AS BUILT
DATE: 10/24/97
MONTGOMERY WATSON
PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT
GENERAL SITE PLAN
C-1
3
2
1
D
C
B
A



5
4
D
C
B
A
2" PVC PVC 80 GROUNDWATER PIPE FROM EXTRACTION WELLS
1 1/2" PVC SCH 40 COOLING WATER SUPPLY FROM WATER SUPPLY
1 1/2" PVC SCH 40 COOLING WATER DRAIN
1 1/2" COPPER
OG-1
OD-1
LT-4
CP-1
WALL MOUNTED 8' HIGH (TYP)
1 1/2" SS SCH 40S OZONE MAIN FEEDER LINE
BLDG. 2L-8
OD-1
OGS-1
2" PVC PVC 80 GROUNDWATER PIPE FROM EXTRACTION WELLS
3/8" SOFTENER FEED TUBING FROM WATER SUPPLY
2" PVC SCH 80 OZONE EXHAUST HEADER TO OZONE DESTRUCTOR
1 1/2" SS SCH 40S OZONE MAIN FEEDER FROM OZONE GENERATOR
MX-1
LSL 601
LSL 602
DT-1
DT-2
1 1/2" PVC SCH 40
DF-2
DF-1
2" PVC SCH 80 FROM EXTRACTION WELL
2" PVC SCH 40 WATER SUPPLYLINE FROM FIRE HYDRANT
1 1/2" PVC SCH 40 TO OZONE GENERATOR COOLING SYSTEM
M-1 (FIT-203)
FLEX PE TUBING (TYP)
CO-1
IMX-1
LSH 313
3" PVC SCH 80
5'-6"
7'-0"
6'-6"
OT-1
OT-2
2" PVC SCH 40 WATER SUPPLY LINE ATTACH TO OUTSIDE OF CONTAINMENT WALL
HOSE BIBB (TYP OF 2) 1'-0" ABOV CONTAINME
CONNECTI OZONE WITH 1/4"
24-OCT-1997 14:20
14:20
directory/filename
1



4
3
2
OOLING WATER DRAIN
1½" COPPER OXYGEN LINE
48'-0"
⅜" SOFTENER FEED TUBING FROM WATER SUPPLY
SOFTNER DRAIN
2" PLANT DISCHARGE TO DRAINAGE DITCH
2" PVC SCH 40
80 OZONE ADER TO RUCTOR
ON WELL
MX-1
LSL 601
LSL 602
MX-2
CO
WS-1
M-2 (FIT-701)
¼" SOFTENER PRODUCT TUBING
DT-1
DT-2
GAC-3
GAC-2
GAC-1
1½" PVC SCH 40
TK-3
DF-4
DF-2
DF-3
DF-5
DF-1
DF-6
DF-7
DT-3
M-1 (FIT-203)
FLEX PE TUBING (TYP)
3'X2'X2' (DEEP) SUMP
LS 902
SP-1
CO-1
MX-3
LSL 611
1" PVC SCH 40
IMX-1
LSH 313
TK-2
P-2
3" PVC SCH 80
2" PVC SCH 40
5'-6"
7'-0"
6'-6"
7'-0"
7'-0"
7'-0"
OT-1
OT-2
OT-4
OT-4
OT-5
OT-6
CONNECTION TO OZONE MONITOR WITH ¼" COCK
TOP OF PIPE EL 11'-0" ABOVE FINISH FLOOR
2" PVC SCH 40 WATER SUPPLY LINE ATTACH TO OUTSIDE OF CONTAINMENT WALL
HOSE BIBB (TYP OF 2) 1'-0" ABOVE CONTAINMENT WALL
OZONE MONITOR STATION MOUNTED TOP OF WALL BOTTOM ELVATION 3'-0" ABOVE FINISHED FLOOR
2
4
3
2



EXISTING 12' x 12' PAD
OST-1
EVAPORATOR
TO 1½" COPPER PIPE OXYGEN VAPORIZER
SOFTNER DRAIN
2" PLANT DISCHARGE TO DRAINAGE DITCH
2" PVC SCH 40
M-2 (FIT-701)
GAC-3
GAC-2
GAC-1
TK-3
3'X2'X2' (DEEP) SUMP
LS 902
SP-1
DF-7
OT-3
DF-6
MX-3
LSL 611
TK-2
1" PVC SCH 40
2" PVC SCH 40
P-2
7'-0"
7'-0"
OT-4
OT-5
OT-6
TOP OF PIPE EL 11'-0" ABOVE FINISH FLOOR
OZONE MONITOR STATION MOUNTED TOP OF WALL BOTTOM ELVATION 3'-0" ABOVE FINISHED FLOOR
3
AS BUILT
DATE: 10/24/97
MONTGOMERY WATSON
PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT
FACILITY PLAN
T. S. LEE
STEVE
MONTGOMERY WATSON
M-1

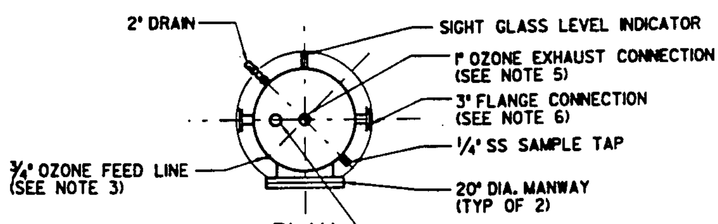
5 | 4

D

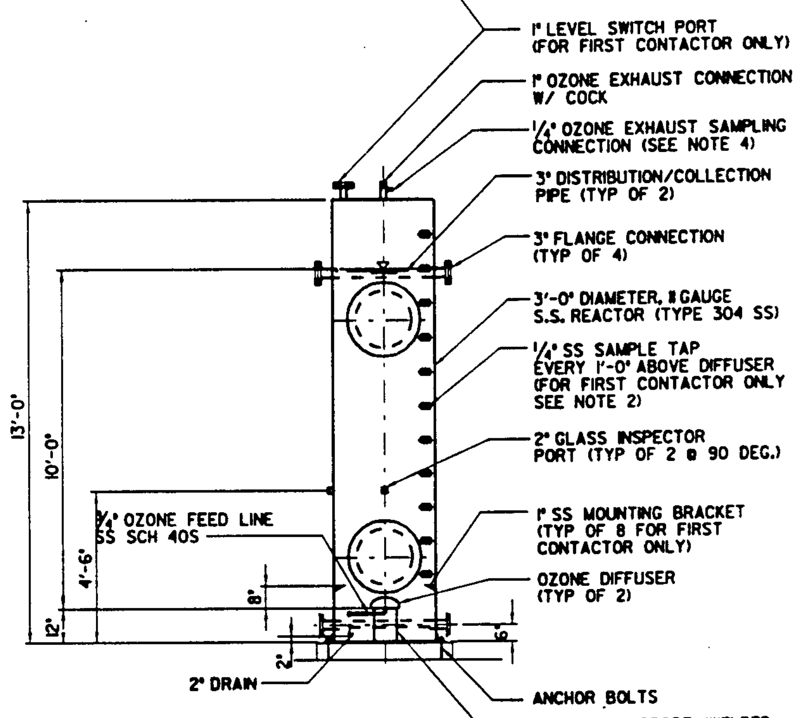
C

B

A



PLAN



ELEVATION

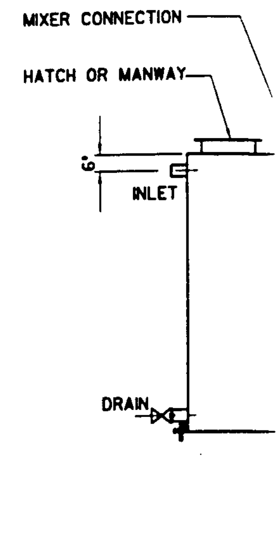
NOTES :

1. ALL PIPE FITTINGS AND BOLTS SS 304
2. 1/4" SS SAMPLE PIPE INSERTED TO CENTER OF CONTACTOR W/ SAMPLE PORT UPWARD. SAMPLE PIPE EXTENDS TO 3'-0" ABOVE FINISHED FLOOR W/ COCK
3. TEFLON TUBING USED TO CONNECT 3/4" OZONE FEED LINE FROM 1 1/2" OZONE MAIN FEEDER. ROTAMETER INSTALLED AT 3/4" OZONE FEED LINE AT EACH CONTACTOR W/ NEEDLE VALVE.
4. TEFLON TUBING USED TO OZONE MONITOR STATION
5. TEFLON TUBING USED TO 2" MAIN EXHAUST HEADER
6. 150 LB FLANGE CONNECTION TO PVC SCH 80 VALVE AND PIPING
7. OZONE DIFFUSER HAS A 7" DIAMETER CERAMIC DOME W/ SS BASE AND VITON GASKET

OZONE CONTACTOR

NOT TO SCALE

1



TYPICAL

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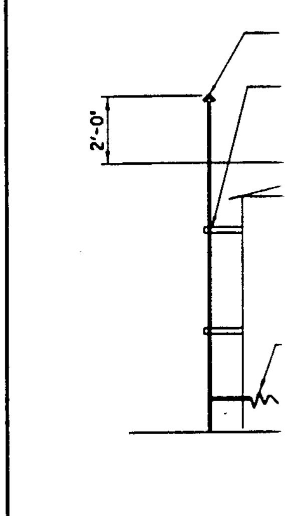
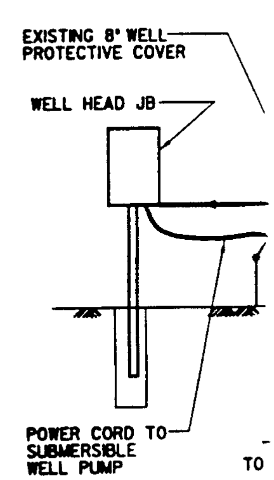


NO



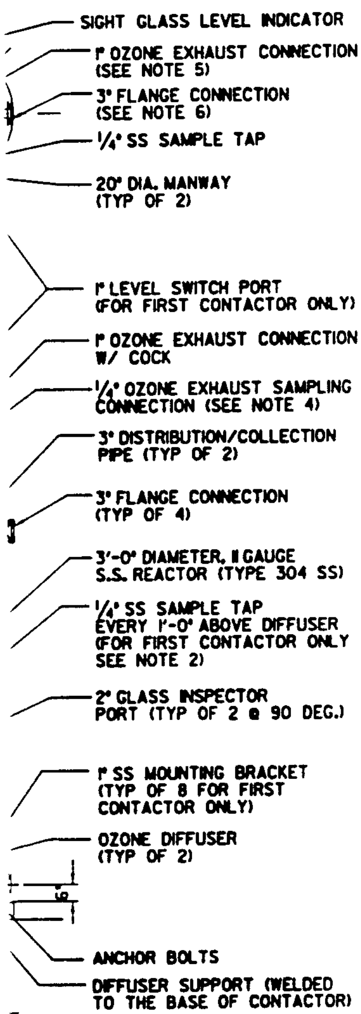
NOTE:
WELL PUMP INSTALLED 6" ABOVE THE BOTTOM OF THE

WELL HE

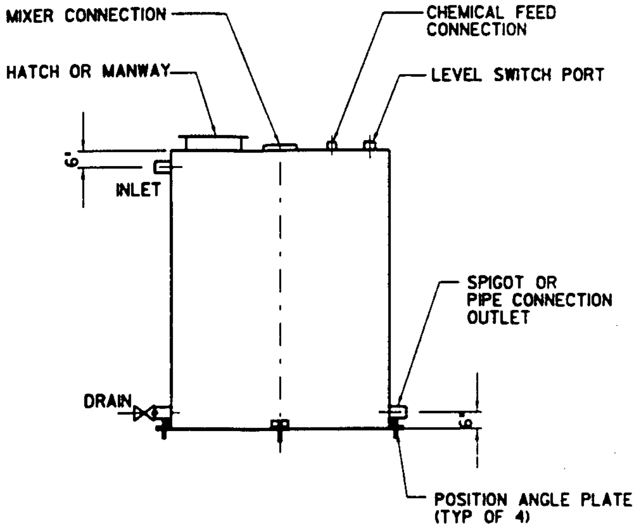
NOT

24-OCT-1997 14:22
14:22

5 | 4

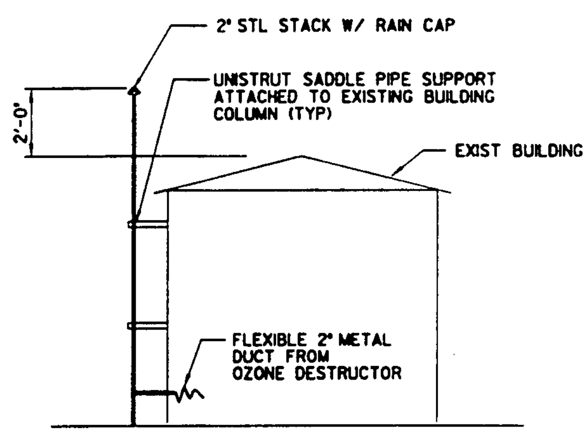


R OF
PLE PIPE
OR W/ COCK
ONE FEED LINE
ER INSTALLED
CTOR W/ NEEDLE VALVE.
STATION
T HEADER
80 VALVE AND PIPING
RAMIC DOME



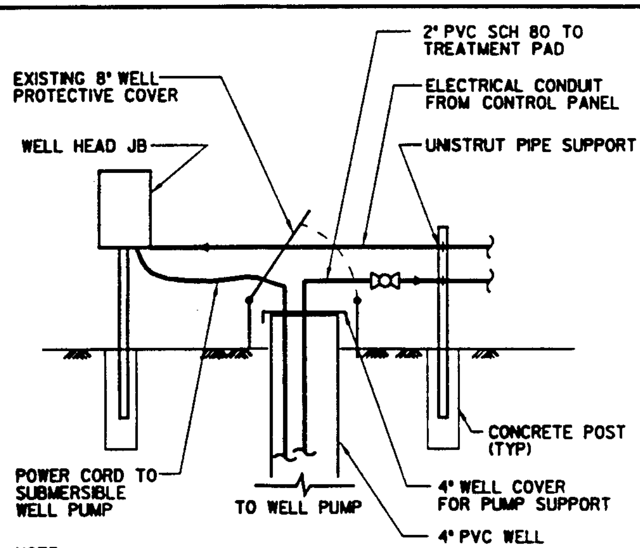
TYPICAL TANK SECTION

NOT TO SCALE



STACK

NOT TO SCALE



NOTE:
WELL PUMP INSTALLED 6" ABOVE THE BOTTOM OF THE WELL

2

WELL HEAD MODIFICATION

NOT TO SCALE

MECHANICAL EQUIPME

EQUIP. NO.	NAME	DESCRIPTION
	NEW TRW WELL	EXISTING 4" OR LARGER CASING
	EXTRACTION WELL NO.66	EXISTING 4" OR LARGER CASING
EP-1	EXTRACTION PUMP NO. 1	SUBMERSIBLE WELL PUMP
EP-2	EXTRACTION PUMP NO. 2	SUBMERSIBLE WELL PUMP
M-1	INFLUENT FLOW METER	PADDLE WEEL TYPE METER
IMX-1	H_2O_2 MIXER	H_2O_2 IN-LINE MIXER
OT-1	OZONE CONTACTOR NO.1	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
OT-2	OZONE CONTACTOR NO.2	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
OT-3	OZONE CONTACTOR NO.3	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
OT-4	OZONE CONTACTOR NO.4	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
OT-5	OZONE CONTACTOR NO.5	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
OT-6	OZONE CONTACTOR NO.6	UNPACKED COLUMN W/CO-CURR & COUNTER-CURRENT FLOW
TK-2	EFFLEUNT STORAGE TANK	POLYETHYLENE WASTE WATER STORAGE TANK
P-2	TRANSFER PUMP NO. 2	CENTRIFUGAL, END-SUCTION PU
GAC-1	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.
GAC-2	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.
GAC-3	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.
M-2	EFFLUENT FLOW METER	PADDLE WEEL TYPE METER
OST-1	OXYGEN STORAGE TANK	LIQUIDOXYGEN STORAGE TANK
OV-1	OXYGEN VAPORIZER	LOCAL/MANUAL CONTROL VAPORIZER
OG-1	OZONE GENERATOR	CAPACITY 100 LB/DAY
DT-1	H_2O_2 DAY TANK NO.1	POLYETHYLENE TANK
DT-2	H_2O_2 DAY TANK NO.2	POLYETHYLENE TANK
DT-3	SODIUM THIOSULFATE DAY TANK	POLYETHYLENE TANK
DF-1	CHEMICAL FEEDER NO.1	ELECTRONIC METERING PUMP
DF-2	CHEMICAL FEEDER NO.2	ELECTRONIC METERING PUMP
DF-3	CHEMICAL FEEDER NO.3	ELECTRONIC METERING PUMP
DF-4	CHEMICAL FEEDER NO.4	ELECTRONIC METERING PUMP
DF-5	CHEMICAL FEEDER NO.5	ELECTRONIC METERING PUMP
DF-6	CHEMICAL FEEDER NO.6	ELECTRONIC METERING PUMP
DF-7	CHEMICAL FEEDER NO.7	ELECTRONIC METERING PUMP
OD-1	OZONE DESTRUCTOR	LOCAL/MANUAL CONTROL DESTRUCTOR
OGS-1	OFF GAS STACK	
MX-1	MIXER NO. 1	CHEMICAL MIXER
MX-2	MIXER NO. 2	CHEMICAL MIXER
MX-3	MIXER NO. 3	CHEMICAL MIXER
WS-1	WATER SOFTENER	RO SYSTEM
TK-3	SOFTENED WATER STORAGE TANK	POLYETHYLENE TANK
NG-1	NITROGEN GENERATOR	
SP-1	SUMP PUMP	SUBMERSIBLE SUMP PUMP

3 | 2 | 1

EMICAL FEED
NNECTION

EVEL SWITCH PORT

— SPIGOT OR
PIPE CONNECTION
OUTLET

OSITION ANGLE PLATE
YP OF 4)

N CAP

E SUPPORT
G BUILDING

EXIST BUILDING

VC SCH 80 TO
ATMENT PAD

CTRICAL CONDUIT
M CONTROL PANEL

STRUT PIPE SUPPORT

CONCRETE POST
(TYP)

WELL COVER
R PUMP SUPPORT

PVC WELL

N

MECHANICAL EQUIPMENT SCHEDULE

EQUIP. NO.	NAME	DESCRIPTION	CRITERIA	REMARKS
	NEW TRW WELL	EXISTING 4" OR LARGER CASING WELL	GROUNDWATER LEVEL 8' BGS	25 GPM
	EXTRACTION WELL NO.66	EXISTING 4" OR LARGER CASING WELL	GROUNDWATER LEVEL 8' BGS	15 GPM
EP-1	EXTRACTION PUMP NO. 1	SUBMERSIBLE WELL PUMP	25 GPM, 75' TDH, 3/4 HP ELEC.	GRUNDFOS 25S, 208V
EP-2	EXTRACTION PUMP NO. 2	SUBMERSIBLE WELL PUMP	25 GPM, 75' TDH, 3/4 HP ELEC.	GRUNDFOS 25S, 208V
M-1	INFLUENT FLOW METER	PADDLE WEEL TYPE METER	0-30 GPM, INSTANT./TOTALIZER	4-20mA SIGNET
IMX-1	H_2O_2 MIXER	H_2O_2 IN-LINE MIXER	2" PVC SCH. 80, 4-ELEMENT, W/SIDE PORT.	KOMAX
OT-1	OZONE CONTACTOR NO.1	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
OT-2	OZONE CONTACTOR NO.2	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
OT-3	OZONE CONTACTOR NO.3	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
OT-4	OZONE CONTACTOR NO.4	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
OT-5	OZONE CONTACTOR NO.5	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
OT-6	OZONE CONTACTOR NO.6	UNPACKED COLUMN W/CO-CURRENT & COUNTER-CURRENT FLOW	500 GAL. 3' DIA. X 13' (H) W/2 DOME DIFFUSER	304 SS
TK-2	EFFLEUNT STORAGE TANK	POLYETHYLENE WASTE WATER STORAGE TANK	500 GAL. 46" DIA. X 76" (H)	
P-2	TRANSFER PUMP NO. 2	CENTRIFUGAL, END-SUCTION PUMP	25 GPM, 50' TDH, 3/4HP, 3500 RPM	
GAC-1	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.	EBCT 10 MIN. EACH AT 25 GPM FLOW	CALGON CYCLESORB FPI
GAC-2	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.	EBCT 10 MIN. EACH AT 25 GPM FLOW	LEASED
GAC-3	GRANULAR ACTIVATED CARBON VESSEL	CARBON QUANTITY 1000 LB.	EBCT 10 MIN. EACH AT 25 GPM FLOW	LEASED
M-2	EFFLUENT FLOW METER	PADDLE WEEL TYPE METER	0-30 GPM, INSTANT./TOTALIZER	4-20mA SIGNET
OST-1	OXYGEN STORAGE TANK	LIQUIDOXYGEN STORAGE TANK	3000 GAL.	LEASED
OV-1	OXYGEN VAPORIZER	LOCAL/MANUAL CONTROL VAPORIZER	500 SCFH @ 15 PSI DISCHARGE	LEASED
OG-1	OZONE GENERATOR	CAPACITY 100 LB/DAY	OZONE DOSAGE (EACH VESSEL) 55MG/L @ 10X O @ 25 GPM	LEASED
DT-1	H_2O_2 DAY TANK NO.1	POLYETHYLENE TANK	275 GAL. 42" DIA. X 48" (H)	
DT-2	H_2O_2 DAY TANK NO.2	POLYETHYLENE TANK	275 GAL. 42" DIA. X 48" (H)	
DT-3	SODIUM THIOSULFATE DAY TANK	POLYETHYLENE TANK	50 GAL. 23" DIA. X 42.75" (H)	
DF-1	CHEMICAL FEEDER NO.1	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE OR EQUAL
DF-2	CHEMICAL FEEDER NO.2	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
DF-3	CHEMICAL FEEDER NO.3	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
DF-4	CHEMICAL FEEDER NO.4	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
DF-5	CHEMICAL FEEDER NO.5	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
DF-6	CHEMICAL FEEDER NO.6	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
DF-7	CHEMICAL FEEDER NO.7	ELECTRONIC METERING PUMP	2.5 GPH	LMI B12 WITH 4-WAY VALVE
OD-1	OZONE DESTRUCTOR	LOCAL/MANUAL CONTROL DESTRUCTOR	CAPACITY 8.5 SCFM	LEASED
OGS-1	OFF GAS STACK			2 INCH SCH 40 STEEL
MX-1	MIXER NO. 1	CHEMICAL MIXER	1/3 HP, 36" LONG SHAFT	
MX-2	MIXER NO. 2	CHEMICAL MIXER	1/3 HP, 36" LONG SHAFT	
MX-3	MIXER NO. 3	CHEMICAL MIXER	1/3 HP, 36" LONG SHAFT	
WS-1	WATER SOFTENER	RO SYSTEM		CULLIGAN
TK-3	SOFTENED WATER STORAGE TANK	POLYETHYLENE TANK	500 GAL., 52" DIA.X60" (H) TRANSFER PUMP	
NG-1	NITROGEN GENERATOR		SMALL COMPRESSOR	
SP-1	SUMP PUMP	SUBMERSIBLE SUMP PUMP	5 GPM, 12' TDH	LITTLE GIANT

D

C

B

A

AS BUILT
DATE: 10/24/97

MONTGOMERY WATSON

PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT

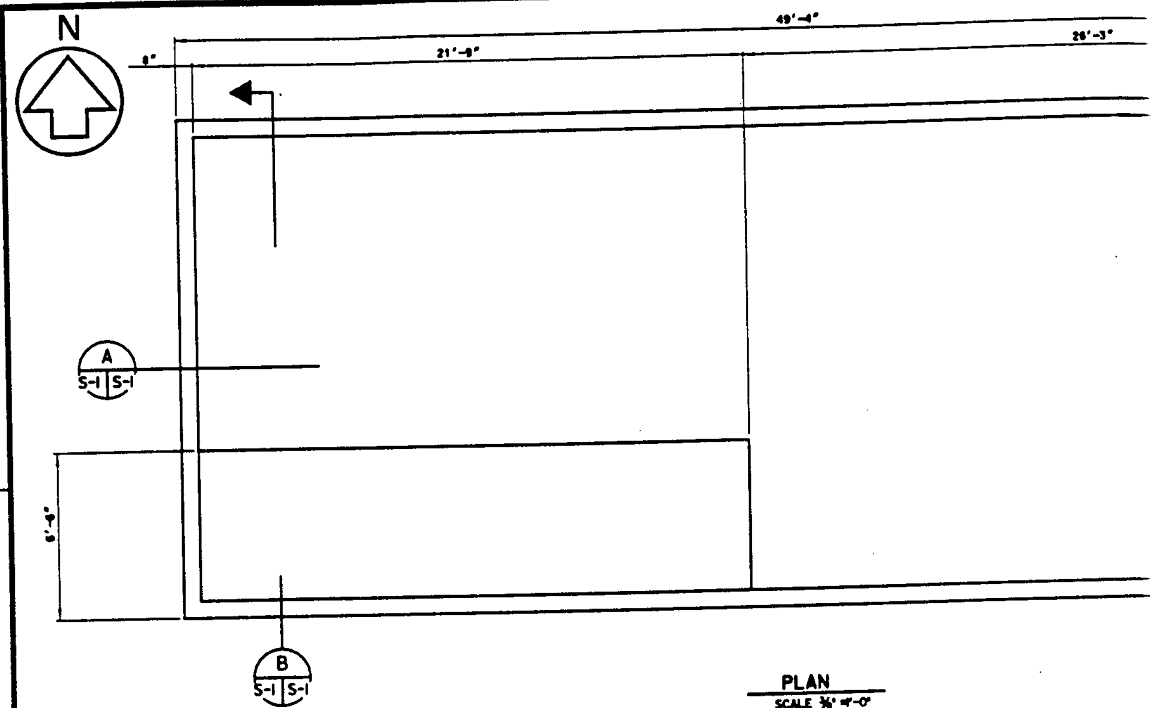
EQUIPMENT SCHEDULE AND DETAILS

T. S. LOH

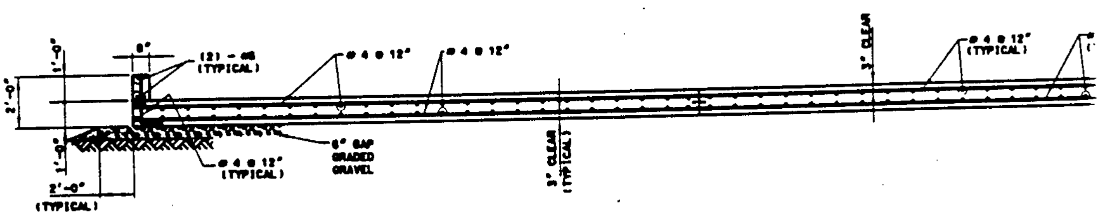
M-2

3

3 | 2 | 1

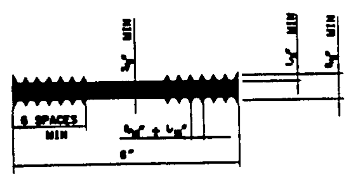


PLAN
SCALE 3/8" =1'-0"

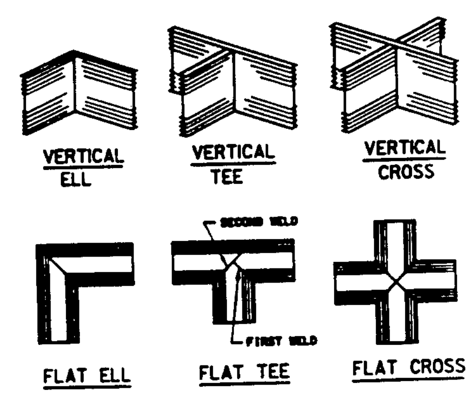


SECTION A S-1 | S-1
SCALE 3/4" =1'-0"

SECTION B S-1 | S-1
SCALE 3/8" =1'-0"



6" FLATSTRIP WATERSTOP
NO SCALE
S-105

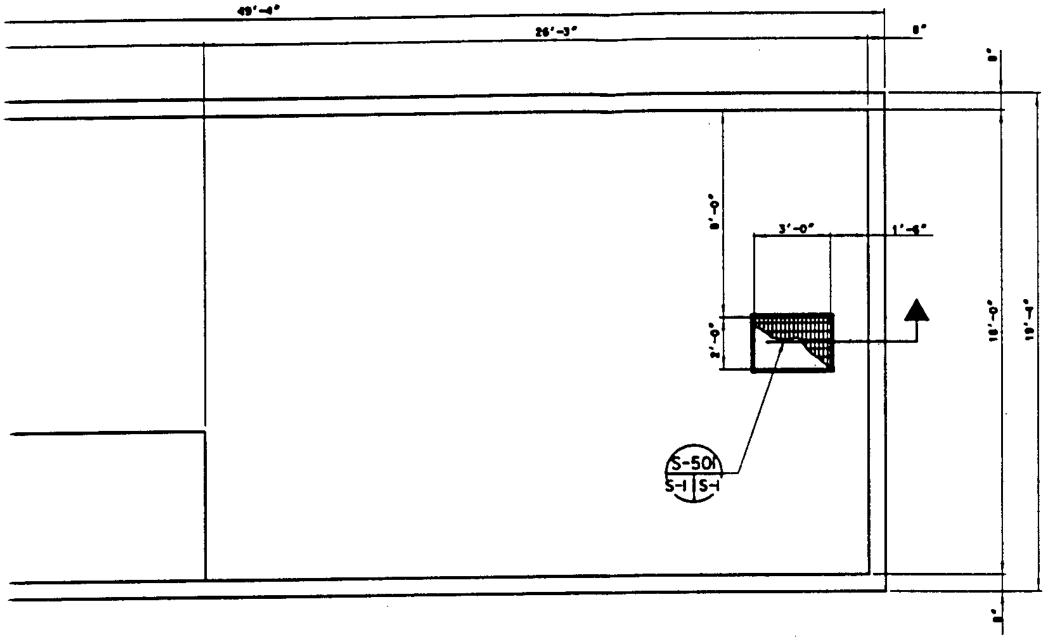


PREFABRICATED WATERSTOPS JOINTS
NO SCALE
S-108

24-OCT-1997 14:23
14:23
directory/filename

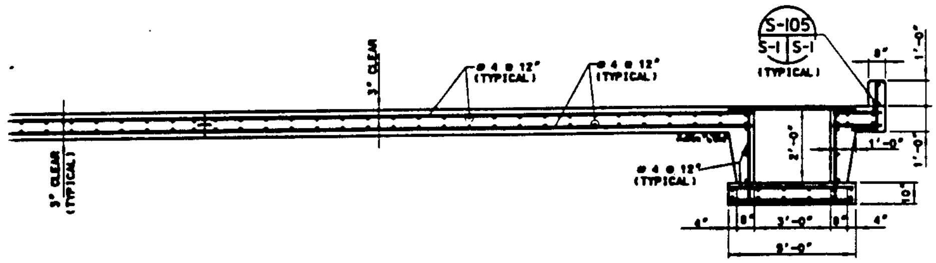
1

5 4

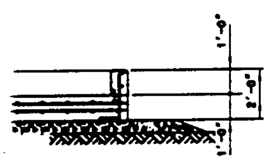


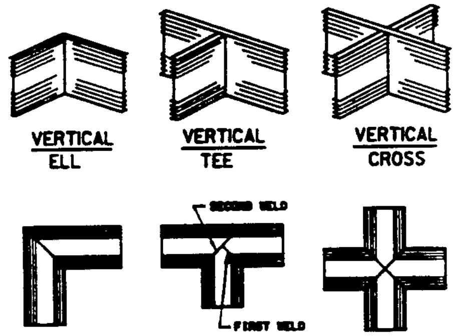
NOTES:
1. CO…
2. RE…
3. CO… RE…
4. ALL… CR…
5. …

PLAN
SCALE 3/8" =1'-0"

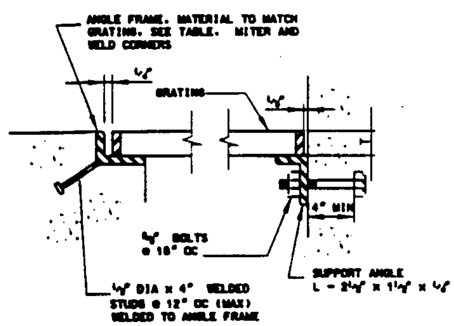


SECTION A S-1 | S-1
SCALE 1/4" =1'-0"





PREFABRICATED WATERSTOPS JOINTS S-108
NO SCALE



GRATING FRAME TABLE	
GRATING DEPTH	FRAME ANGLE
1"	1 3/4 x 1 1/4 x 1/4

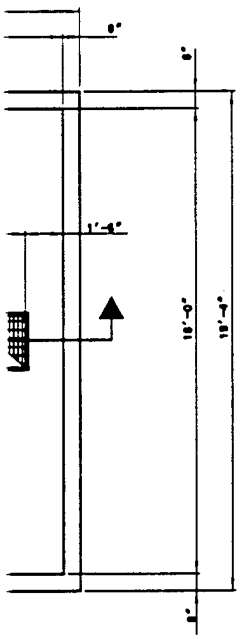
NOTES:

1. GRATING DEPTH DETERMINED BY MANUFACTURER AND APPROVED BY ENGINEER (UNO)
2. ALL ENDS AND OPENINGS BANDED
3. ALL GRATING SECURED IN PLACE WITH REMOVABLE FASTENERS. SEE DETAIL S-517
4. WEIGHT OF GRATING SECTION NOT TO EXCEED 80 LBS
5. BEARING BARS SHALL BE DEPTH T x 3/16" @ 1 3/16" OC CROSS BARS SHALL BE @ 4" OC

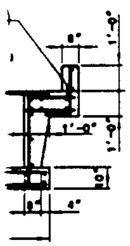
STEEL GRATING S-501
USE STEEL ANGLE SUPPORTS AND STAINLESS STEEL BOLTS
NO SCALE

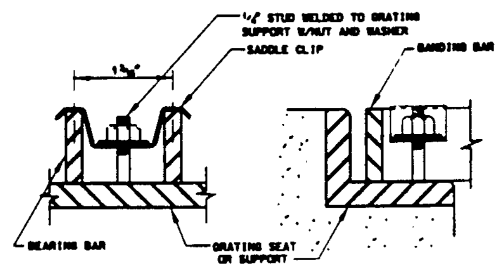
2

2 | 1



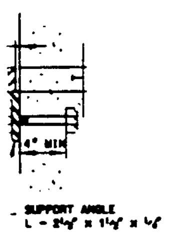
NOTES:
1. CONCRETE STRENGTH AT 28-DAYS $\geq$ 3000 PSI(MIN)
   CONCRETE WILL HAVE THE FOLLOWING OTHER REQUIREMENTS:
   a) SLUMP= 3-INCH ± 1-INCH
   b) MAXIMUM WATER-CEMENT RATIO = 0.50
   c) AIR ENTRAINMENT 6% ± 1 %
   d) THREE TEST CYLINDERS BY A TESTING AGENCY TO VERIFY STRENGTH.
2. REINFORCING PER ASTM A615 GRADE 60.
3. CONCRETE AND CONCRETE PLACEMENT PER THE REQUIREMENTS OF ACI 318, AND ACI 301.
4. ALUMINUM BAR GRATING. BEARING AND BANDING BARS TO BE ALLOY 6061-T6. CROSS BARS TO BE ALLOY 6063-T5.
5. 3/4" DIAMETER TANK ANCHOR BOLTS TO BE DRILLED INTO THE CONCRETE 9-INCHES.





NOTES:
1. 4 CLIPS PER GRATING PANEL. APPROX 4" FROM PANEL CORNERS. MAXIMUM CLIP SPACING AT 36" OC
2. STUD, NUT, WASHER AND CLIP ARE THE SAME MATERIAL AS THE GRATING EXCEPT FOR ALUMINUM USE SS
3. AT FRP GRATING USE 1/2" FRP ALL TREAD BOLTS AND ADHESIVE ANCHORS AS APPROPRIATE

GRATING ANCHOR DETAIL (S-517)
NO SCALE



NOTES:
1. GRATING DEPTH DETERMINED BY MANUFACTURER AND APPROVED BY ENGINEER (UNO)
2. ALL ENDS AND OPENINGS BANDED
3. ALL GRATING SECURED IN PLACE WITH REMOVABLE FASTENERS. SEE DETAIL S-517
4. WEIGHT OF GRATING SECTION NOT TO EXCEED 80 LBS
5. BEARING BARS SHALL BE DEPTH T x 3/16" @ 1 3/16" OC
   CROSS BARS SHALL BE @ 4" OC

STEEL GRATING (S-501)
USE STEEL ANGLE SUPPORTS AND STAINLESS STEEL BOLTS
NO SCALE

AS BUILT
DATE: 10/24/97

Symbol	Description	Date	Approved
1	AS BUILT - RH 08/10/97	08/10/97	EAJ
2	AS BUILT FINAL - RH 10/24/97	10/24/97	EAJ

MONTGOMERY WATSON | TRW SPACE & TECHNOLOGY DIVISION

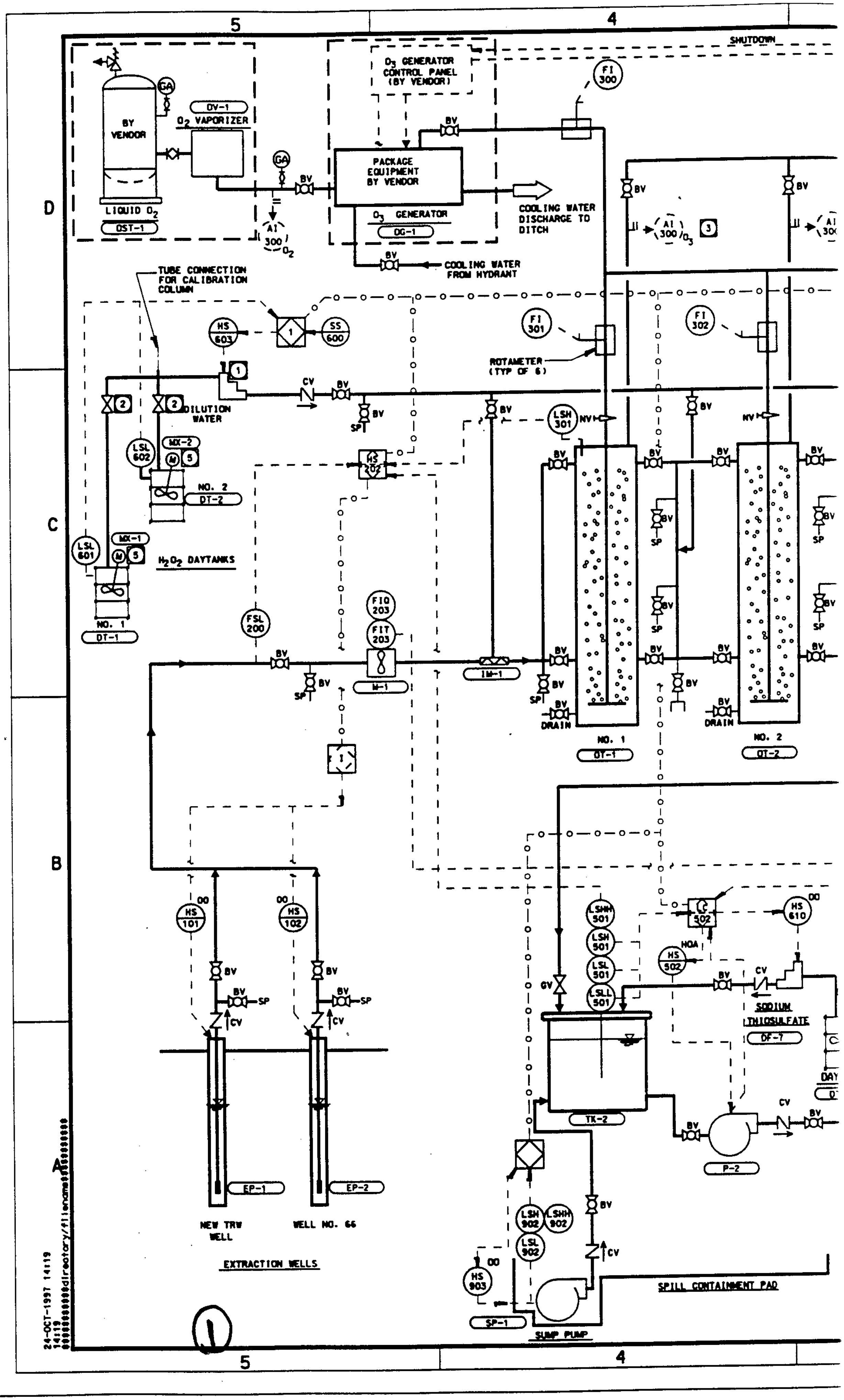
PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMEY AMMUNITION PLANT

STRUCTURAL PLAN, SECTIONS, AND DETAILS

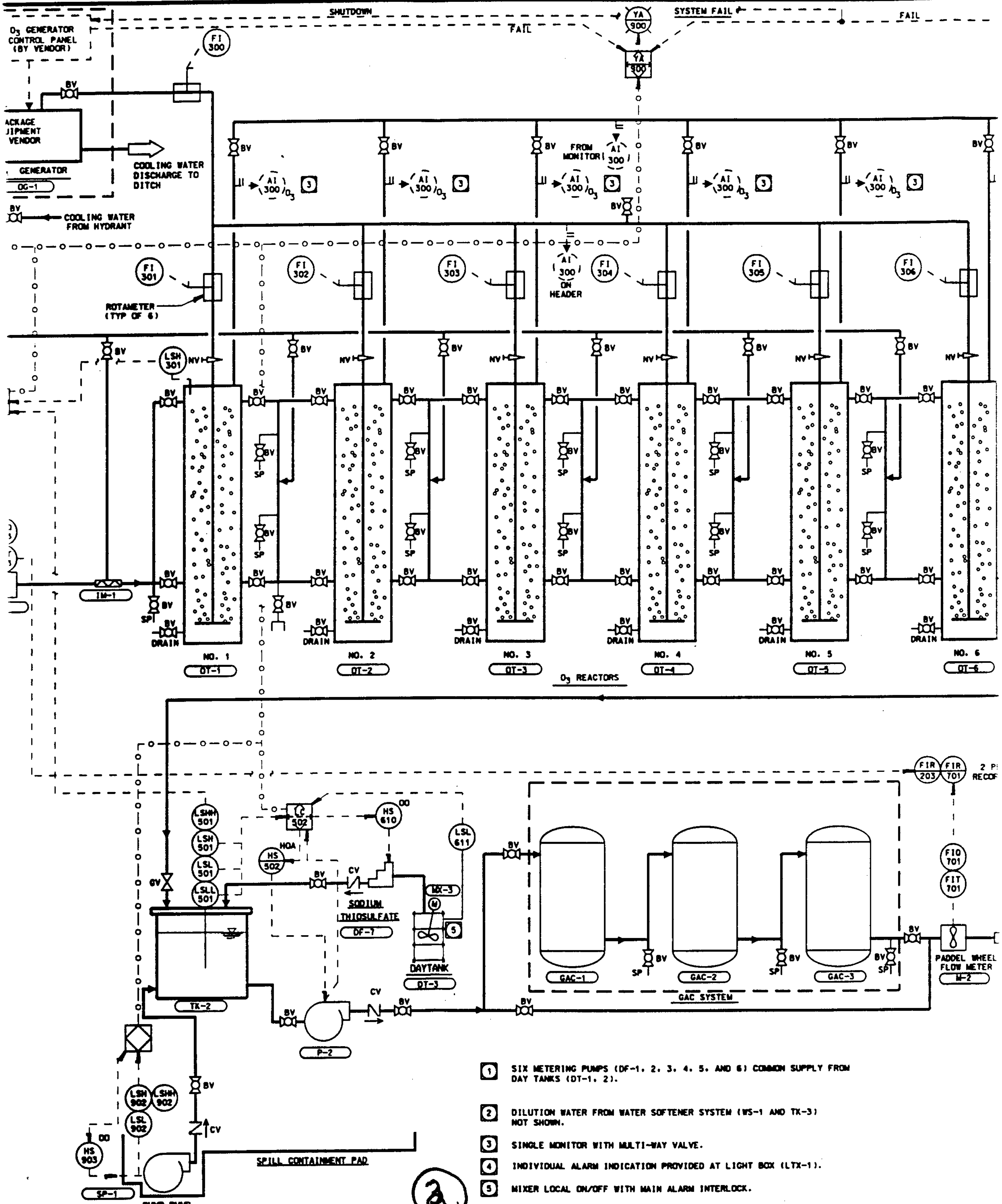
Designed by	B. HIGLEY
Drawn by	R. GARCIA
Checked by	H.B. CHANG
Reviewed by	R. SCHLICHER
Submitted by	MONTGOMERY WATSON
Scale	AS SHOWN
Sheet reference number	S-1

(3)

2 | 1

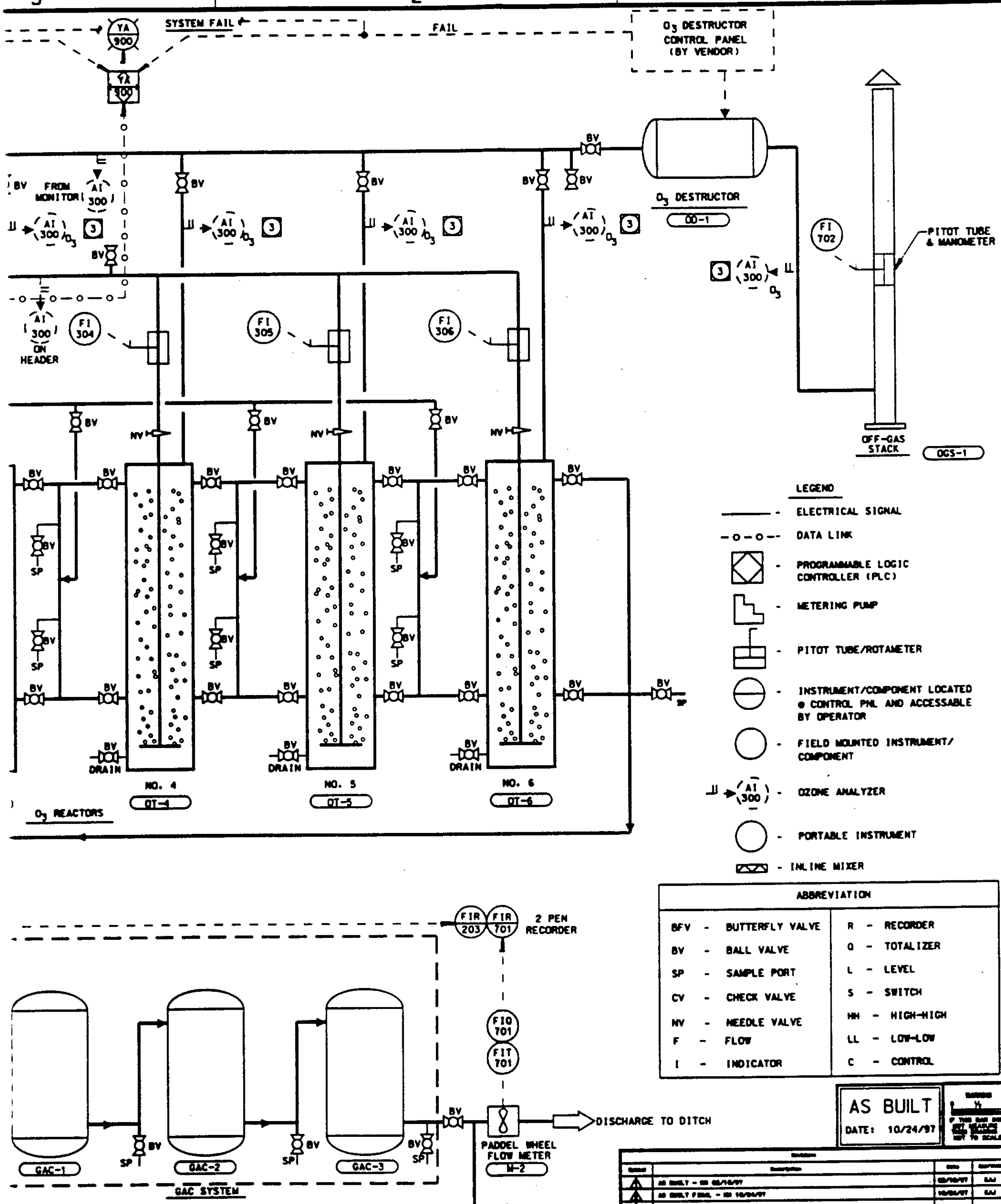


5
4
SHUTDOWN
O_3 GENERATOR CONTROL PANEL (BY VENDOR)
FI 300
BY VENDOR
GA
DV-1
O_2 VAPORIZER
BV
PACKAGE EQUIPMENT BY VENDOR
COOLING WATER DISCHARGE TO DITCH
LIQUID O_2
OST-1
AI 300 O_2
O_3 GENERATOR
OG-1
AI 300/O_3
3
COOLING WATER FROM HYDRANT
TUBE CONNECTION FOR CALIBRATION COLUMN
HS 603
SS 600
FI 301
FI 302
ROTAMETER (TYP OF 6)
CV
DILUTION WATER
SP
LSH 301
NV
LSL 602
MX-2
HS 202
NO. 2
DT-2
LSL 601
MX-1
H_2O_2 DAYTANKS
NO. 1
DT-1
FSL 200
FIQ 203
FIT 203
M-1
IM-1
DRAIN
NO. 1
OT-1
NO. 2
OT-2
HS 101
HS 102
OO
LSHH 501
LSH 501
LSL 501
LSLL 501
HS 502
HOA
HS 610
GV
SODIUM THIOSULFATE
DF-7
DAY
TK-2
P-2
EP-1
EP-2
NEW TRW WELL
WELL NO. 66
EXTRACTION WELLS
LSH 902
LSHH 902
LSL 902
HS 903
SP-1
SUMP PUMP
SPILL CONTAINMENT PAD
24-OCT-1997 14:19
1



1. SIX METERING PUMPS (DF-1, 2, 3, 4, 5, AND 6) COMMON SUPPLY FROM DAY TANKS (DT-1, 2).
2. DILUTION WATER FROM WATER SOFTENER SYSTEM (WS-1 AND TX-3) NOT SHOWN.
3. SINGLE MONITOR WITH MULTI-WAY VALVE.
4. INDIVIDUAL ALARM INDICATION PROVIDED AT LIGHT BOX (LTX-1).
5. MIXER LOCAL ON/OFF WITH MAIN ALARM INTERLOCK.

2



ABBREVIATION

BFV	BUTTERFLY VALVE	R	RECORDER
BV	BALL VALVE	Q	TOTALIZER
SP	SAMPLE PORT	L	LEVEL
CV	CHECK VALVE	S	SWITCH
NV	NEEDLE VALVE	HH	HIGH-HIGH
F	FLOW	LL	LOW-LOW
I	INDICATOR	C	CONTROL

ETERING PUMPS (DF-1, 2, 3, 4, 5, AND 6) COMMON SUPPLY FROM
ANKS (DT-1, 2).

ION WATER FROM WATER SOFTENER SYSTEM (WS-1 AND TK-3)
HOWN.

E MONITOR WITH MULTI-WAY VALVE.

IDUAL ALARM INDICATION PROVIDED AT LIGHT BOX (LTX-1).

LOCAL ON/OFF WITH MAIN ALARM INTERLOCK.

3

AS BUILT
DATE: 10/24/97

MONTGOMERY WATSON

PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT

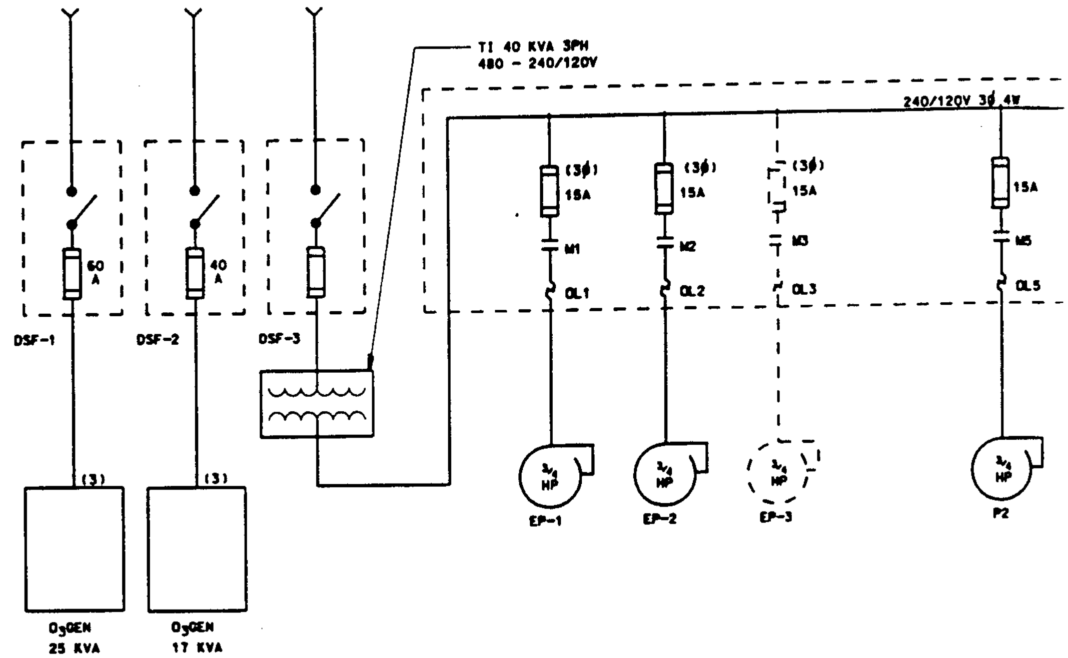
PROCESS & INSTRUMENTATION DIAGRAM

NONE

I-1

5 4

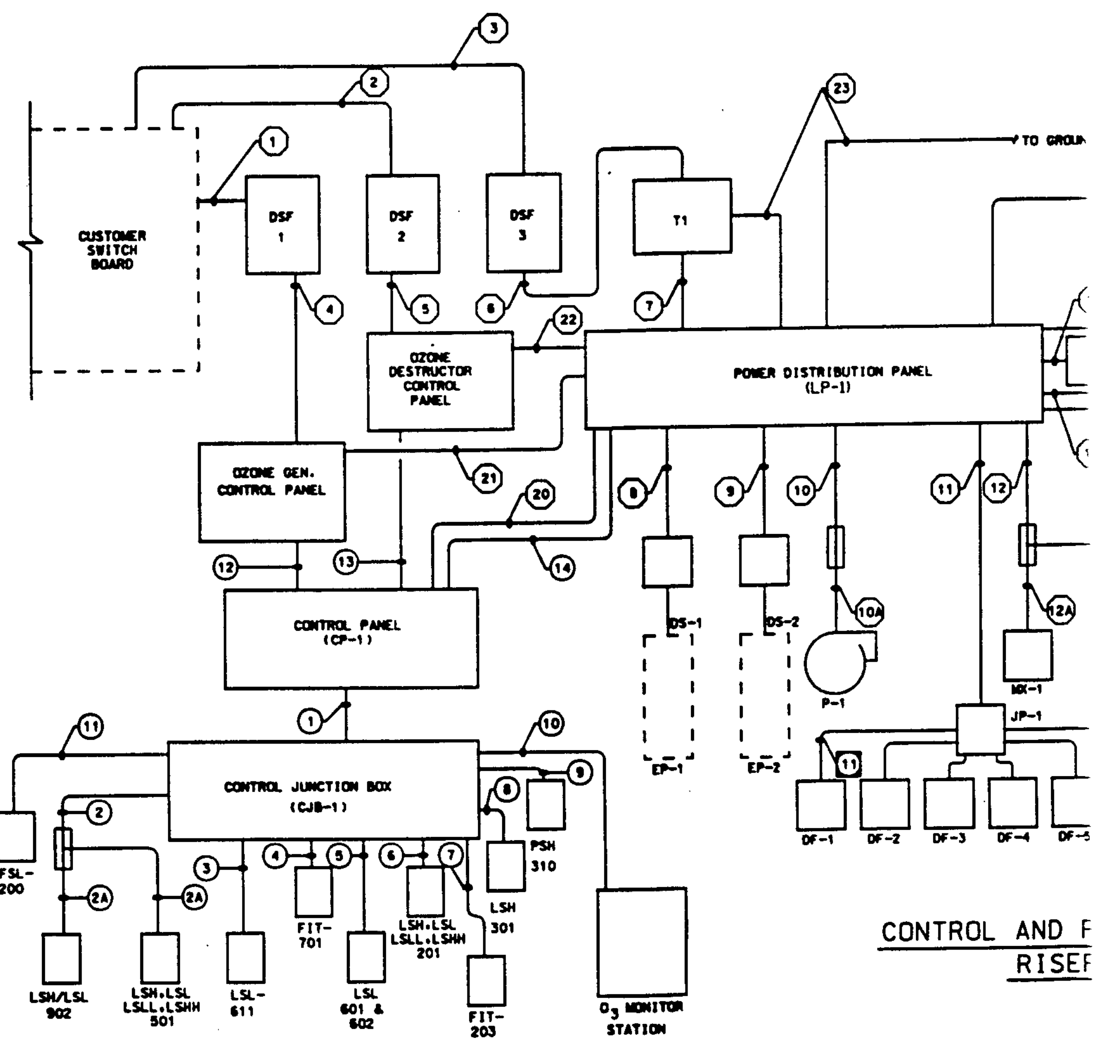
D



C

POWER DISTRIBUTION SING LELINE DIAGRAM

B



A

CONTROL AND F
RISEF

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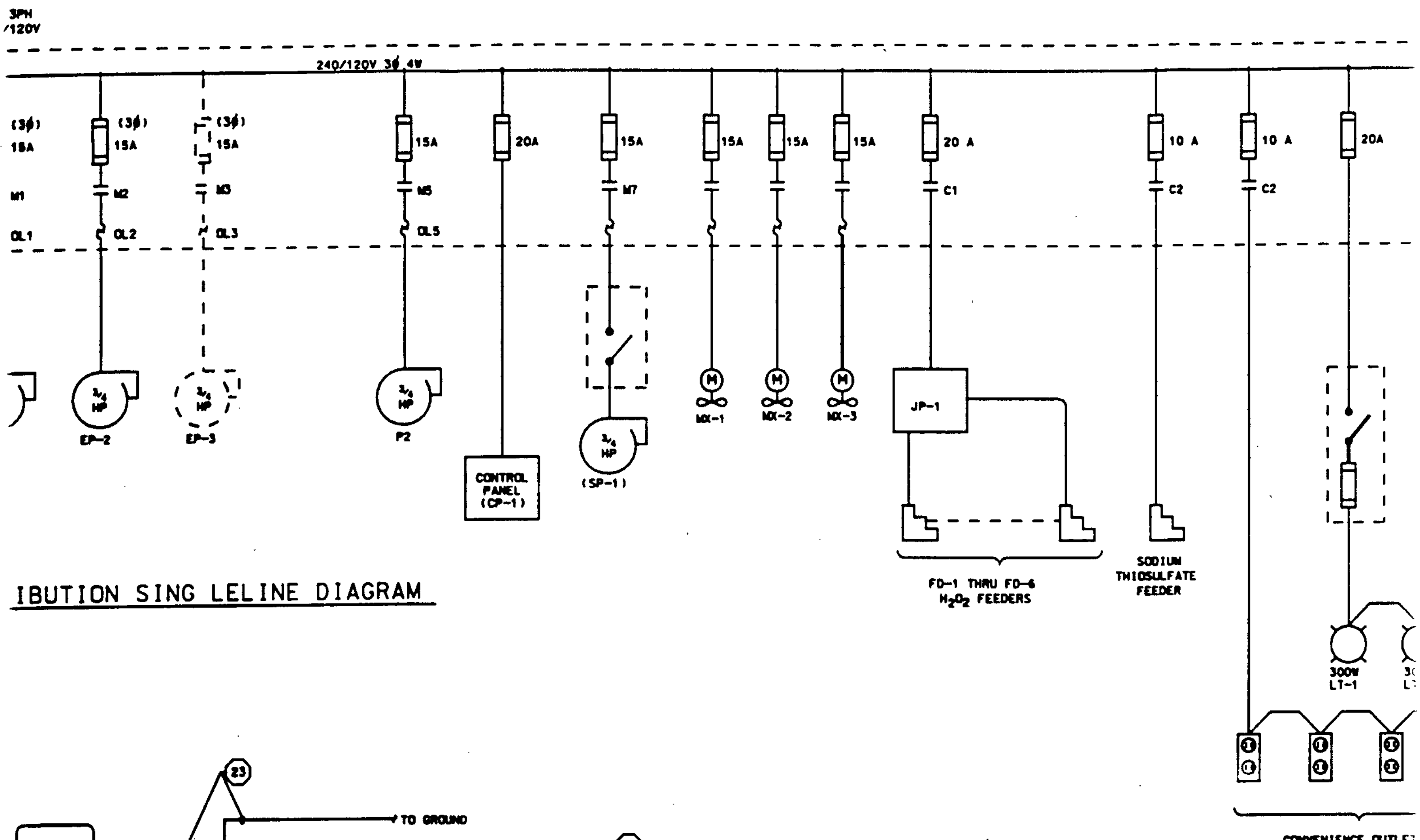
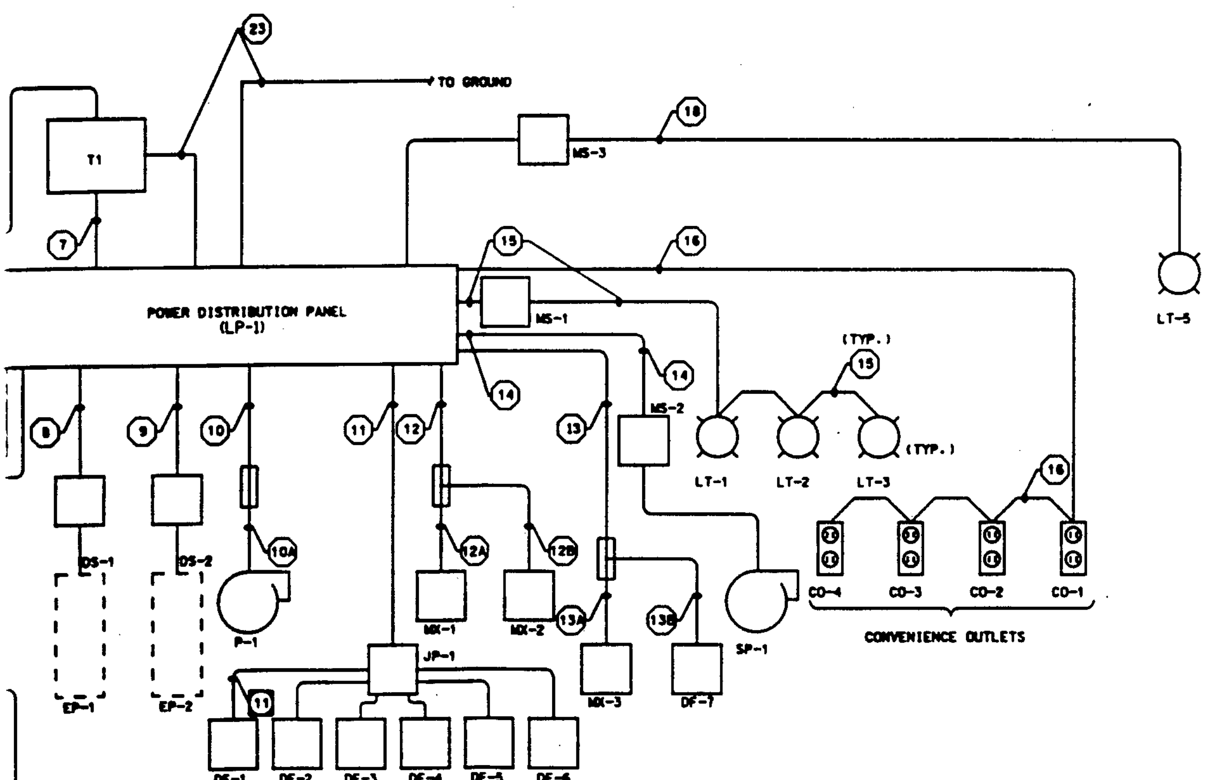
5 4

4	3	2



IBUTION SING LELINE DIAGRAM



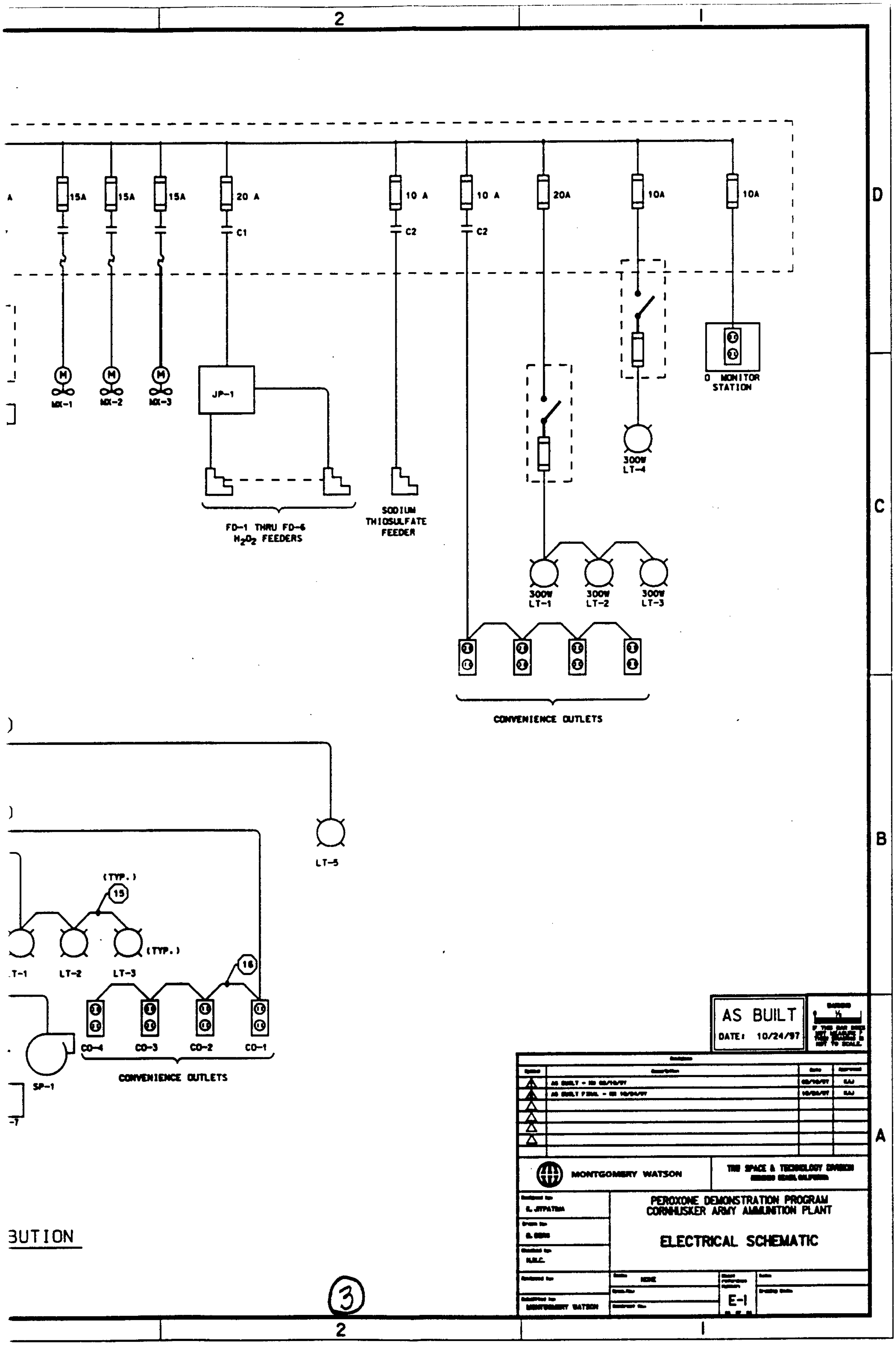
CONTROL AND POWER DISTRIBUTION
RISER DIAGRAM

O_3 MONITOR
STATION

2

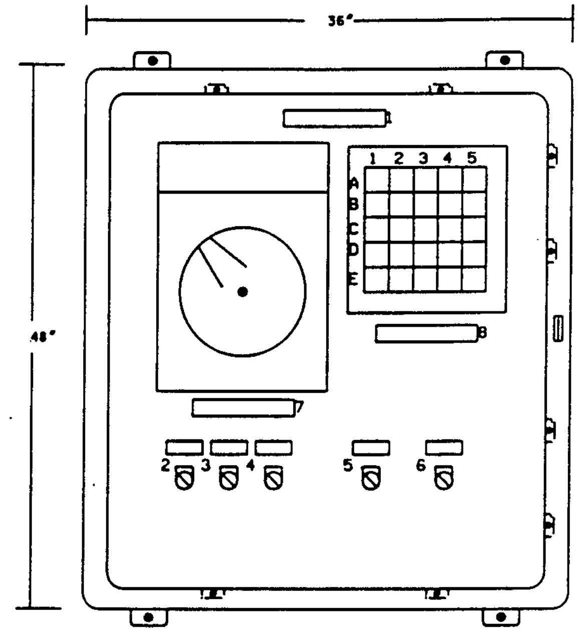
MONT
S. JITPATMA

4	3	2



2
1
D
C
B
A
15A
15A
15A
20 A
C1
10 A
C2
10 A
C2
20A
10A
10A
MX-1
MX-2
MX-3
JP-1
FD-1 THRU FD-6
H_2O_2 FEEDERS
SODIUM
THIOSULFATE
FEEDER
O MONITOR
STATION
300W
LT-4
300W
LT-1
300W
LT-2
300W
LT-3
CONVENIENCE OUTLETS
LT-5
(TYP.)
15
(TYP.)
LT-1
LT-2
LT-3
16
CO-4
CO-3
CO-2
CO-1
CONVENIENCE OUTLETS
SP-1
BUTION
AS BUILT
DATE: 10/24/97
MONTGOMERY WATSON
PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT
ELECTRICAL SCHEMATIC
NONE
MONTGOMERY WATSON
E-1

3



CP-1 ENCLOSURE (FRONT VIEW)
(NTS)

PANEL (CP-1) LAY

NAMEPLATE AND LEGEND PLATE SCHEDULE		
ITEM	NAMEPLATE	LEGEND
1	CONTROL PANEL-1 (CP-1)	-
2	WELL PUMP, EP-1	ON-OFF
3	WELL PUMP, EP-2	ON-OFF
4		
5		
6	EFFLUENT PUMP, P-2	HAND-OFF-AUTO
7	INFLUENT FLOW-GPM (FIR-203) EFFLUENT FLOW-GPM (FIR-701)	- -
8	LIGHT BOX-1 (LTX-1)	-

LIG	
ITEM	LINE
A-1	WELL PU
A-2	WELL PU
~~A-3~~	~~WELL PU~~
A-4	SYSTEM
~~A-5~~	~~EQUALI~~
B-1	WELL PU
B-2	WELL PU
~~B-3~~	~~WELL PU~~
B-4	OZONE
B-5	EFFLUEN
~~C-1~~	~~INF. PU~~
C-2	EFF. PU
C-3	SUMP
C-4	OZONE
~~D-1~~	~~INF. PU~~
D-2	EFF. PU
D-3	DAY TAN
D-4	DAY TAN
D-5	DAY TAN

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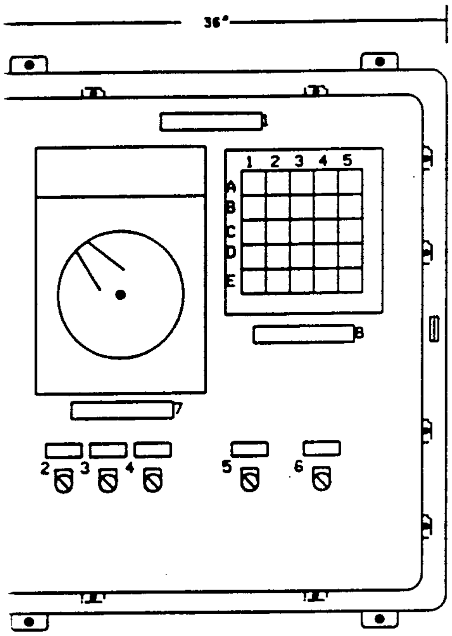
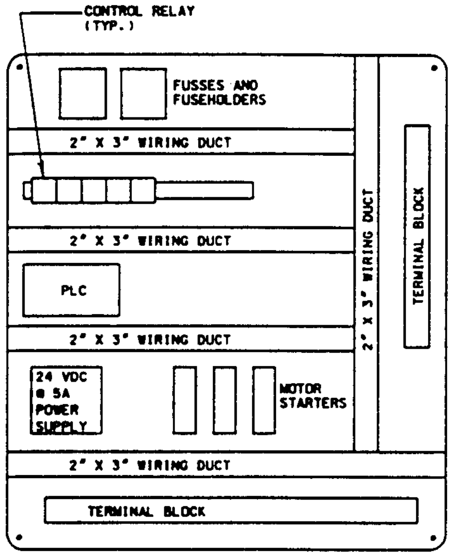
14:17
$$$$$$$$$directory/filename$$$$$$$$$

(1)



CP-1 ENCLOSURE (FRONT VIEW)
(NTS)



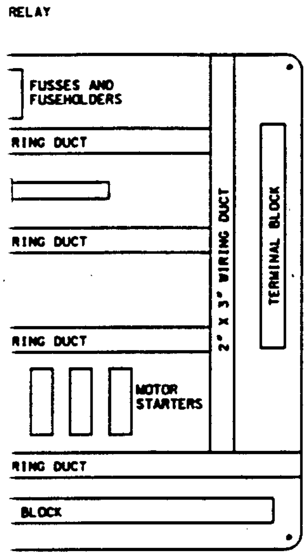
BACK PANEL LAYOUT
(NTS)

PANEL (CP-1) LAYOUT

NAMEPLATE AND LEGEND PLATE SCHEDULE	
NAMEPLATE	LEGEND
CONTROL PANEL-1 (CP-1)	-
WELL PUMP, EP-1	ON-OFF
WELL PUMP, EP-2	ON-OFF
EFFLUENT PUMP, P-2	HAND-OFF-AUTO
INFLUENT FLOW-GPM (FIR-203)	-
EFFLUENT FLOW-GPM (FIR-701)	-
LIGHT BOX-1 (LTX-1)	-

LIGHTBOX-1 (LTX-1) SCHEDULE				
ITEM	LINE 1	LINE 2	LINE 3	
A-1	WELL PUMP	EP-1	RUN	
A-2	WELL PUMP	EP-2	RUN	
~~A-3~~	~~WELL PUMP~~	~~EP-3~~	~~RUN~~	DELETED
A-4	SYSTEM	-	FAILURE	
~~A-5~~	~~EQUALIZATION~~	~~TANK LEVEL~~	~~HIGH~~	DELETED
B-1	WELL PUMP	EP-1	FAILURE	
B-2	WELL PUMP	EP-2	FAILURE	
~~B-3~~	~~WELL PUMP~~	~~EP-3~~	~~FAILURE~~	DELETED
B-4	OZONE	GENERATOR	FAILURE	
B-5	EFFLUENT	TANK LEVEL	HIGH	
~~C-1~~	~~INF. PUMP~~	~~P-1~~	~~RUN~~	DELETED
C-2	EFF. PUMP	P-2	RUN	
C-3	SUMP	LEVEL	HIGH	
C-4	OZONE	DESTRUCTOR	FAILURE	
~~D-1~~	~~INF. PUMP~~	~~P-1~~	~~FAILURE~~	DELETED
D-2	EFF. PUMP	P-2	FAILURE	
D-3	DAY TANK 1	LEVEL	LOW	
D-4	DAY TANK 2	LEVEL	LOW	
D-5	DAY TANK 2	LEVEL	LOW	

2



:K PANEL LAYOUT
(NTS)

CHEDULE		
	LINE 3	
	RUN	
	RUN	
	~~RUN~~	DELETED
	FAILURE	
~~EL~~	~~HIGH~~	DELETED
	FAILURE	
	FAILURE	
	~~FAILURE~~	DELETED
R	FAILURE	
EL	HIGH	
	~~RUN~~	DELETED
	RUN	
	HIGH	
R	FAILURE	
	~~FAILURE~~	DELETED
	FAILURE	
	LOW	
	LOW	
	LOW	

AS BUILT
DATE: 10/24/97

MONTGOMERY WATSON

PEROXONE DEMONSTRATION PROGRAM
CORNHUSKER ARMY AMMUNITION PLANT

PANEL LAYOUTS

E-2

(3)

Appendix E

Project Experimental Plan

CORNHUSKER ARMY AMMUNITION PLANT

PEROXONE GROUNDWATER TREATMENT PROJECT

EXPERIMENTAL PLAN

submitted to:

TRW Space & Technolgoy

Prepared by:

MONTGOMERY WATSON
250 North Madison Avenue
Pasadena, CA 91101

JULY 5, 1996

TABLE OF CONTENTS

SECTION 1
INTRODUCTION & GENERAL APPROACH

1.1: INTRODUCTION

TRW Space and Technology retained the services of Montgomery Watson to design, construct, and operate a 25 gpm Peroxone groundwater treatment demonstration plant. The groundwater at the Cornhusker Army Ammunition Plant (CAAP) in Grand Island, Nebraska is contaminated with various energetic compounds, including TNT, RDX, TNB, and other nitrobodies. The objective of the project is to determine the ozone dose, hydrogen peroxide dose, and hydraulic retention time needed to reliably achieve the required removals of these contaminants to acceptable levels. The anticipated levels of contaminant concentrations in the groundwater, and their respective treated water goals are listed in Table 1.

Table 1

Anticipated Contaminant Levels and Corresponding Treated Water Goals

Contaminant	Anticipated Groundwater Concentration (mg/L)	Target Concentration After Peroxone Treatment (mg/L)
TNT	0.5	0.002
RDX	0.2	0.002
TNB	0.1	0.002
Total Nitrobodies	1.0	0.030

Figure 1 shows a schematic of the groundwater treatment demonstration plant. The design of the demonstration plant includes six (6) ozone contactors in series with ozone and hydrogen peroxide fed independently to each contactor. A GAC contactor is provided at the effluent side of the plant with an EBCT of 30 minutes at 25 gpm to ensure that no contaminants are discharged with the plant water during testing. The maximum design applied ozone dose to each contactor is 60 mg/L for a total applied ozone dose of 360 mg/L. The hydrogen peroxide system is designed to deliver a maximum of 18 mg/L to each contactor for a total of 108 mg/L at 25 gpm (this provides a H_2O_2/Ozone Ratio of 0.3 mg/mg). At the design flow rate of 25 gpm, the average hydraulic retention time (HRT) in each contactor is 20 minutes for a total system HRT of 120 minutes. The system will be tested on waters from two (2) groundwater wells. The notations used in this document for the two wells are “Well A” and “Well B”.

This document details the experimental plan to be implemented at the demonstration plant to achieve the project objectives.

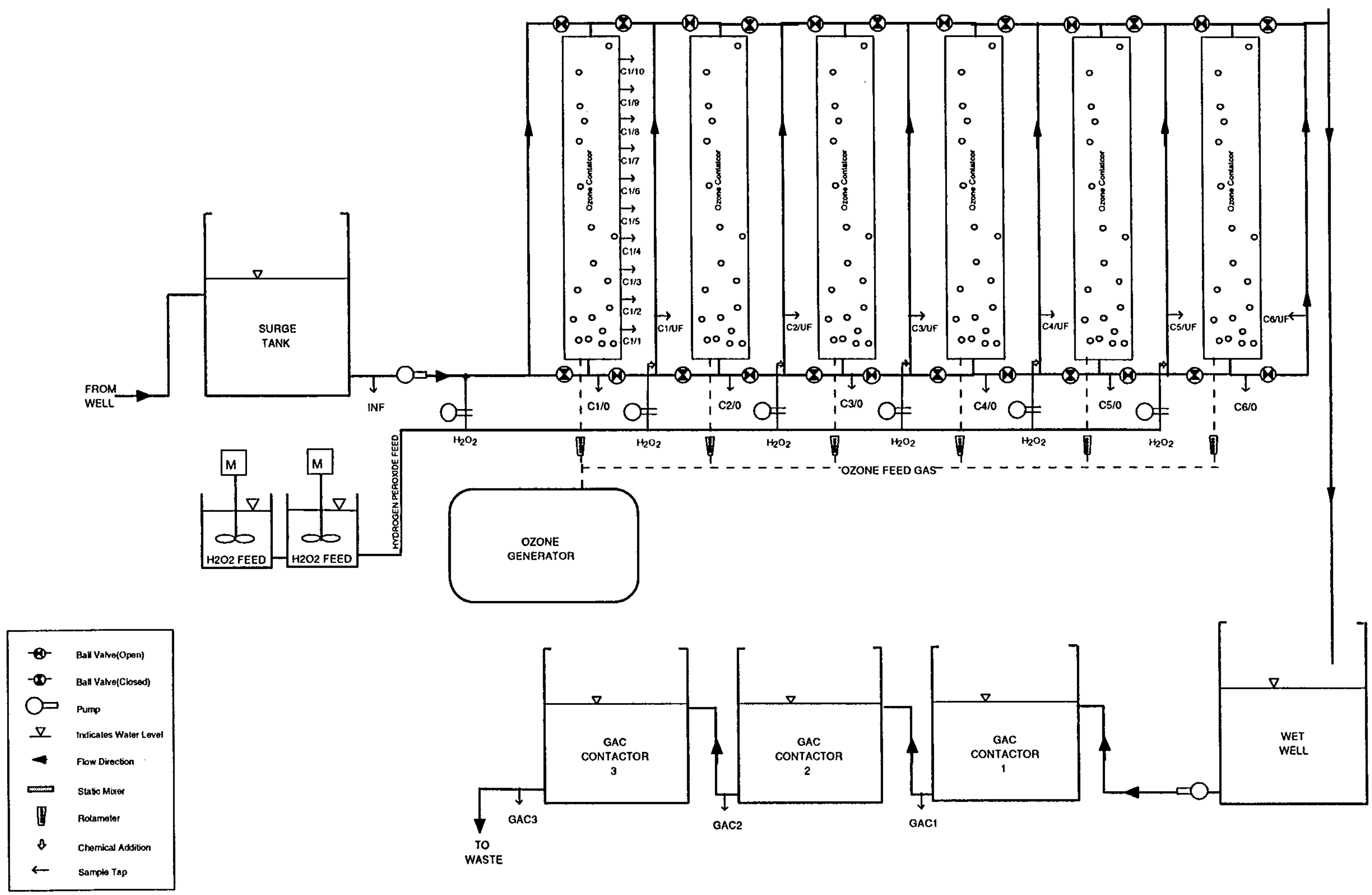


FIGURE 1 PEROXONE DEMONSTRATION PLANT SCHEMATIC

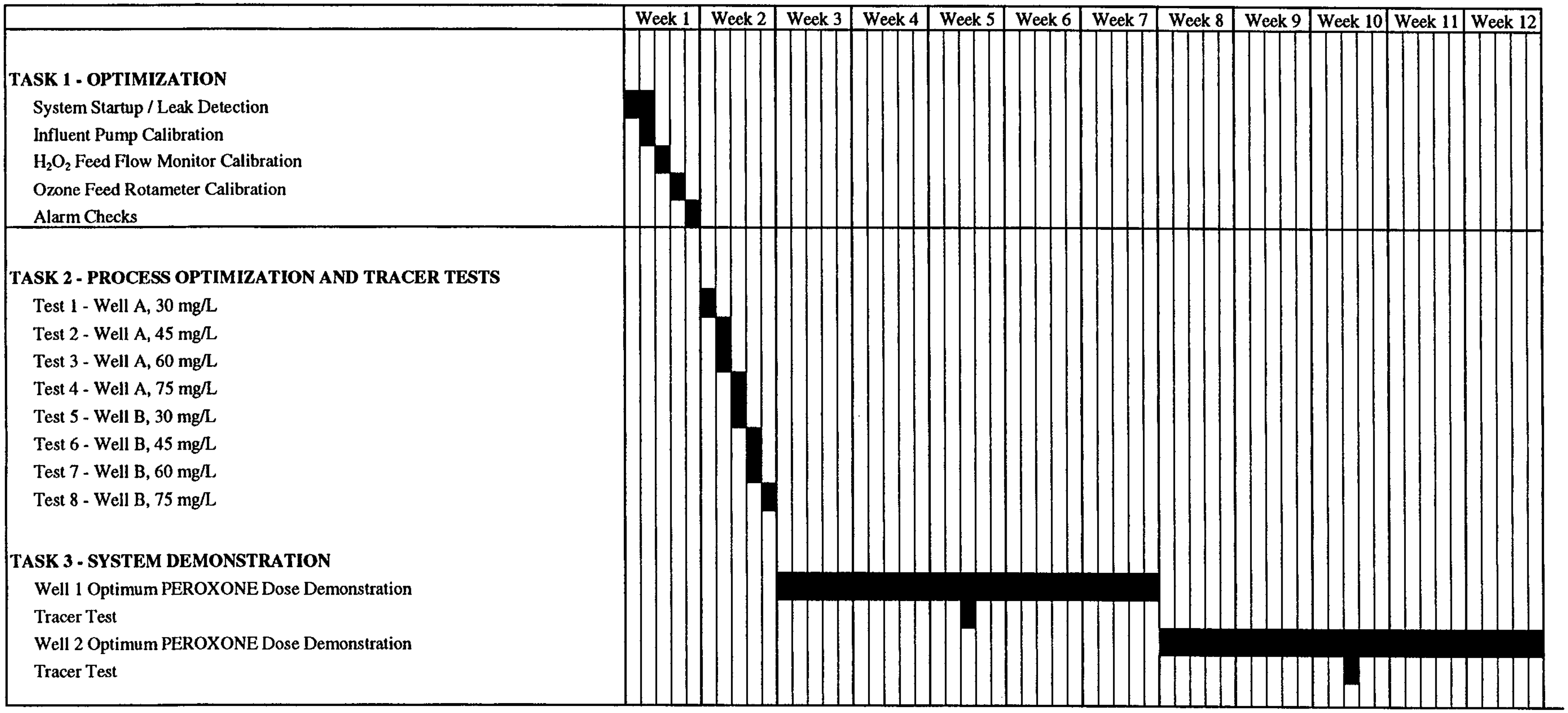


FIGURE 2 PROJECT SCHEDULE

1.2: GENERAL APPROACH

The overall testing schedule, which is planned for a total of 12 weeks, is outlined in Figure 2. After the plant is constructed and all the equipment are installed, the demonstration plant operators will conduct three primary tasks.

1.2.1: Task 1 (1 week):—Conduct System Debugging

During the first week, the plant pumps and chemical feed systems will be started up at a low flow rate (approximately 10 gpm) using tap water, and checked for any water or chemical leaks. The system will also be checked for malfunctions of chemical feed equipment and shut-down alarms. After the leaks and malfunctions, if any, are repaired, the flow rate through the plant will be continuously increased until the design flow of 25 gpm is reached. The plant will then be operated at that flow rate for a period of two (2) hours. During this period all water and chemical feed equipment will be checked for operational stability.

1.2.2: Task 2 (1 week):—Conduct Process Optimization

During the 2nd week, process optimization testing will be conducted using water from each of the two wells. Process optimization will involve operating the system at various ozone doses, collecting water samples from the effluent of each of the six contactors, as well as from the wall taps along the water depth of the first contactor, and analyzing them for ozone residual and target contaminants' concentrations. The applied ozone dose tested will range from 30 mg/L to 75 mg/L. The flowrate will be held constant at the design value of 25 gpm. Since the ozone generator is capable of producing a maximum dose of 60 mg/L at 25 gpm water flowrate, the flowrate will be reduced to 15 gpm when evaluating the ozone dose ranging from 60 mg/L to 75 mg/L. These tests will allow for the determination of the optimum operating conditions that will result in the reduction of the contaminants to their respective target concentrations.

1.2.3: Task 3 (10 weeks):—Conduct System Demonstration

During the period extending from the 3rd week through the 12th week, the system will be operated under constant conditions. This period will serve to demonstrate that the system can achieve the anticipated performance on a long-term basis. The demonstration period will be divided into two (2) segments of 5 weeks each, with water from one of each of the two wells used as the raw water source in each segment. In addition, two tracer tests will be conducted on the system to determine the hydraulic characteristics of the contactor design at the selected water flow rate.

SECTION 2
TESTING PLAN

The following paragraphs detail the tests to be conducted during each task. In order to facilitate the implementation of this experimental plan, Figure 1 includes a schematic of the demonstration plant showing the plant components and all the sampling taps installed. Each tap is letter-coded for ease of identification and sampling tracking.

2.1: TASK 1—CONDUCT SYSTEM DEBUGGING

The objectives of this 1-week task are as follows:

1. start up the demonstration plant,
2. ensure that all its components are fully operational,
3. calibrate all chemical feed systems,
4. test all alarms and emergency shut-down systems, and
5. check for leaks and malfunctions.

The following is a description of the tests to be conducted in this task:

2.1.1: System Startup & Leak Detection

Fill the surge tank with tap water and pump water into the system at an indicated flowrate of 25 gpm to fill up the six contactors with water. When the six contactors and the GAC contactor are full with water, turn off the water flow rate, look for any major leaks, and then wait for 30 minutes and check for any minor leaks throughout the system including, but not limited to, the following:

1. the sides of the contactors
2. sampling taps
3. pipes and pipe connections
4. pumps and chemical injection ports

If any leaks are detected, the leaking component of the system will be isolated, drained from water, and repaired. The system will be refilled with water and re-checked for leaks. This process should be repeated until no leaks are detected.

Once the system is void of leaks, the water will be started at a flow rate of 10 gpm. The ozone system will be turned on, and ozone will be fed to the six contactors at 40 percent of capacity (which should translate into a total dose of 360 mg/L to a flow of 10 gpm). The Soap-Bubble test will be conducted on all gas-phase pipe connections outside the ozone generator, monitor, and destruct unit. While ozone is being fed to the system, the hydrogen peroxide feed system to the six contactors will be turned on. The system will be checked for any hydrogen peroxide leaks. If any leaks in the ozone system or the hydrogen peroxide system are detected, the system will be shut down, and the leaks repaired. This test will be repeated until both feed systems are void of detectable leaks.

After all system components are checked for leaks, the water flow rate will be increased gradually to 25 gpm, accompanied by a corresponding increase in ozone generator setting and hydrogen peroxide feed rate to deliver the design doses of 360 mg/L ozone and 108 mg/L hydrogen peroxide. The system will be operated under these conditions for a period of 30 minutes during which a final leak check will be conducted on all system components.

2.1.2: Equipment Calibration

The following instruments and monitoring equipment will be calibrated during this task:

1. influent water flowmeter
2. hydrogen peroxide metering pumps

2.1.2.1: Influent Water Flowmeter

The influent water flowmeter will be calibrated using a polyethylene 55-gallon drum. Tap water will be used in this test. A total of three (3) indicated flow rates will be evaluated: 10, 18, and 25 gpm. A constant flowrate will be allowed to flow through the flowmeter. The water will be diverted from the effluent of the first contactor through a flexible hose to the drain. After 10 minutes of steady flow, the water will be diverted into the 55-gallon calibration drum. Time will be kept using a stopwatch until the 50 gallon mark is reached. During the test, one operator will watch the flowmeter to ensure that the reading is stable at the test flowrate. The ratio of 50 gallons by the fill time (in minutes) will constitute the actual flowrate value in gpm. This test will be repeated in triplicates for each of the three test flowrates. It is important that the temperature of the water be measured and recorded during each test run. The datasheet to be used in this test is shown in Figure 3. Once the calibration curve is developed, the "actual" flowrate, instead of the "indicated" flowrate, should be used in all subsequent testing.

2.1.2.2: Hydrogen Peroxide Metering Pumps

The column calibration method will be used to calibrate the metering pumps. No water will be flowing through the contactors during this test. However, the contactors should be full. A total of three (3) pump settings will be calibrated for each of the pumps installed. A 50-mL graduated burette will be filled with water and connected to the suction side of the pump being calibrated. The pump is then turned on at one of the three settings being tested. After the first 30 seconds, the timing will begin and the water level in the burette will be read and recorded. Once the water level reaches the 5-mL mark the timer will be stopped. The ratio of the volume drawn (in mL) divided by the draw time (min) will constitute the flow rate in mL/min. This test will be repeated in duplicates for each of the three test settings. The temperature of the test water should be measured and recorded in each test. The datasheet to

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEET

TASK 1 - RAW WATER FLOWMETER CALIBRATION

Date	Time	Target Flowrate gpm	Indicated Flowrate gpm	Fill Volume gallons	Time to Fill, min	Calculated Flowrate gpm	Comment
		10					
		10					
		10					
		18					
		18					
		18					
		25					
		25					
		25					

Note: Tests to be conducted in triplicate at indicated flowrates of 10, 18 and 25 gpm.

FIGURE 3

be used in this test is shown in Figure 4. Once the calibration curve is developed, the "actual" flow rate should be used in all subsequent testing.

2.1.2.3: Ozone Feed-Gas Flowmeters

The ozone gas flowmeters to the six contactors need to be calibrated during this task. A wet gas flowmeter will be leased to the project. The following procedure will be used to calibrate the feed-gas flow meter to each contactor at each of three gas flow settings (0.5, 1, and 2 scfm indicated flow).

1. turn on the gas to the test contactor at one of the three test flowrate settings,
2. connect the wet gas flowmeter to the off-gas line from the test contactor,
3. measure the gas flowrate using the manufacturer's directions.
4. take a duplicate gas flowrate reading,
5. repeat the duplicate measurements at the other two indicated flowrates,
6. repeat the above 5 steps on each of the remaining five contactors.

Note that the ozone generator setting should be at "zero" and the feed-gas should contain no ozone. Also, no water flow through the contactor is necessary. However, it is important that each contactor be full of water to the operating water level. In addition, a pressure gauge and a temperature gauge will be installed downstream of the flowmeter to the first contactor to measure the actual gas temperature and pressure. This information is necessary to correct the gas flow for temperature and pressure. Figure 5 shows the data logsheet to be used to record the data collected from this calibration test.

2.1.3: Alarm Checks

The following alarms will be checked by the operator during this task :

1. Overflow alarm on the 1st contactor,
2. Overflow alarm on the wet well between the 6th contactor and the GAC contactors,
3. Spill alarm in the containment pad, and
4. Overflow alarm on the surge feed tank.

All alarm checks will be conducted using tap water.

2.1.3.1: Overflow Alarm on 1st Contactor

To check whether the overflow alarm on the 1st contactor is operating properly, the valve between the 1st and 2nd contactor will be closed off and tap water will be turned on at 25 gpm flowrate into the 1st contactor. The contactor will fillup until the water reaches the level sensor. At that time, the alarm should shut down the entire power system. This includes the extraction well pumps, influent water pump, transfer pump in the wet well, the ozone generator, and the hydrogen peroxide pumps.

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEET

TASK 1 - CHEMICAL FEED PUMP CALIBRATION

Date	Time	Pump No	Pump Setting	Burrette Start Mark mL	Burrette End Mark mL	Draw Volume mL	Draw Time min.	Measured Flowrate mL/min	Comment

FIGURE 4

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEET

TASK 1 - OZONE GAS FLOWMETER CALIBRATION

Date	Time	Ozone Contactor Number	Gas Flow Setting (scfm)	Measured Gas Flow (scfm)	Gas Pressure (atm)	Gas Temp. (°C)	Comment
		1	0.5				
		1	0.5				
		1	1				
		1	1				
		1	2				
		1	2				
		2	0.5				
		2	0.5				
		2	1				
		2	1				
		2	2				
		2	2				
		3	0.5				
		3	0.5				
		3	1				
		3	1				
		3	2				
		3	2				
		4	0.5				
		4	0.5				
		4	1				
		4	1				
		4	2				
		4	2				
		5	0.5				
		5	0.5				
		5	1				
		5	1				
		5	2				
		5	2				
		6	0.5				
		6	0.5				
		6	1				
		6	1				
		6	2				
		6	2				

FIGURE 5

2.1.3.2: Overflow Alarm on the Wet Well

The same type of test will be conducted on the wet well. The transfer pump between the wet well and the GAC contactor will be turned off. The wet well will be filled with tap water. As the wet well fills up and the water reaches the level sensor, the alarm system should shut down the entire power system. This should include the extraction well pumps, raw water pump, the ozone generator, and the hydrogen peroxide feed pumps.

2.1.3.3: Spill Alarm on Containment Pad

The spill alarm in the containment pad will be checked. Using a flexible hose, tap water will be diverted into the sump of the containment pad. As the pad fills up and the water reaches the level sensor, the alarm should shut down the power system. This should include the extraction pump wells, raw water pump, the transfer pump in the wet well, the ozone generator, and the hydrogen peroxide feed pumps.

2.1.3.4: Overflow Alarm on Surge Tank

Testing of the overflow alarm on the surge tank is similar to that of the alarm on the 1st contactor or the wet well. The pump from the surge tank to the first contactor will be turned off, and the tank will be filled with tap water. As the surge tank fills up and the water reaches the level sensor, the alarm system should shut down the entire power system. This should include the extraction well pumps, raw water pump, the ozone generator, and the hydrogen peroxide feed pumps.

2.2: TASK 2—CONDUCT PROCESS OPTIMIZATION

After completing system startup and instrument calibration, the 1-week process optimization task will begin. The objective of this task is to evaluate contaminant removal under a wide range of ozone dose in order to select the optimum set of conditions for system demonstration. Figure 6 shows the datalogsheet that will be used during each process optimization test. It is noted that all testing will be conducted in a countercurrent flow mode.

This task includes a total of 8 tests to be conducted over a one-week period. The concept behind this task is to run the PEROXONE plant at four applied ozone doses ranging from 30 mg/L to 75 mg/L, which extend well below and above the anticipated required dose of 60 mg/L. The applied doses to be evaluated are 30 mg/L, 45 mg/L, 60 mg/L, and 75 mg/L. All doses, except the 75 mg/L dose, will be evaluated at a hydraulic flowrate of 25 gpm. Due to the limitation of the ozone generator capacity, the flowrate will have to be reduced to 15 gpm in order to evaluate the system performance at the applied dose of 75 mg/L. These tests will be conducted on each of the two wells to be evaluated. All applied and transferred ozone doses will be accurately measured by monitoring the ozone concentration in the feed gas and the off gas streams to and from each of the six contactors. In addition, the hydrogen peroxide stock solution will be prepared at 2% strenght (20,000 mg/L) by diluting the neat 35%

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEETS

TASK 2 - PROCESS OPTIMIZATION TASK

TEST CONDITIONS:

DATE:	
TEST NO.:	
WELL CODE:	
WATER FLOW RATE (gpm):	
FEED-GAS OZONE CONC (mg/L):	
H_2O_2 FEED TANK CONC (mg/L):	

CONTACTOR	CONTACTOR OFF-GAS OZONE CONC (mg/L)	TIME
C1		
C2		
C3		
C4		
C5		
C6		

SAMPLE LOCATION CODE	SAMPLE TIME (24HR)	OZONE RESIDUAL (MG/L)	OZONE RESIDUAL 2 (MG/L) OPTIONAL	CONTAMINANT SAMPLE CODE
INF				02-____-INF-__________
INF				02-____-INF-__________
INF				02-____-INF-__________
INF				02-____-INF-__________
C1/0				02-____-C1/0-__________
C1/UF				02-____-C1/UF-__________
C1/2				02-____-C1/2-__________
C1/4				02-____-C1/4-__________
C1/6				02-____-C1/6-__________
C1/8				02-____-C1/8-__________
C2/0				02-____-C2/0-__________
C2/UF				02-____-C2/UF-__________
C3/0				02-____-C3/0-__________
C3/UF				02-____-C3/UF-__________
C4/0				02-____-C4/0-__________
C4/UF				02-____-C4/UF-__________
C5/0				02-____-C5/0-__________
C5/UF				02-____-C5/UF-__________
C6/0				02-____-C6/0-__________
C6/UF				02-____-C6/UF-__________
C6/0UQ				02-____-C6/0UQ-__________
C6/UFUQ				02-____-C6/UFUQ-__________
GAC3				02-____-GAC3-__________
GAC1				02-____-GAC1-__________
GAC2				02-____-GAC2-__________

Note: "UQ" following sample location designator indicates explosives sample not quenched with Thiosulfate

FIGURE 6

solution with DI water. All throughout these eight tests, the gas flowrate to each contactor will be set at 0.8 scfm.

The following is a detailed description of how each of the eight tests will be conducted.

2.2.1: Test #1 (Week #2; Monday): Conditions: Well A; Flow Rate = 25 gpm; Ozone Dose = 30 mg/L per contactor; H_2O_2 Dose = 9 mg/L per contactor.

At 8:00 AM on Monday morning, set the flow rate through the system at 25 gpm with the ozone generator set to produce an applied dose of 30 mg/L, and the hydrogen peroxide flowrate to each contactor set at 42.3 mL/min which translates into a hydrogen peroxide dose of 9 mg/L to each contactor. At 8:30 AM the concentration of ozone in the feed gas will be measured. If the applied ozone dose is not 30 mg/L ± 3 mg/L, then the ozone generator will be adjusted and rechecked after period of 15 minutes. This process will be repeated until the dose is within this acceptable range. For a water flowrate of 25 gpm, and a gas flowrate of 0.8 scfm, a ozone gas-phase concentration of 125 mg/L will result in the target applied ozone dose of 30 mg/L to each contactor.

Assuming that each contactor is completely mixed, then the six contactors in series can be simulated by six completely stirred tank reactors (CSTRs) in series. Therefore, steady-state conditions are expected to be reached in 4 hours of operating time. While waiting for steady-state conditions to be reached, 4 influent samples will be collected from the surge tank and analyzed for explosives concentrations.

After steady-state conditions are reached, samples will be collected from the effluent of each of the six contactors, as well as from five taps along the water depth of the first contactor. The samples will then be analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors will then be analyzed for ozone gas-phase concentration. It is anticipated that the off-gas ozone concentrations will be different between the six contactors, and therefore it is important that they be measured individually.

2.2.2: Test #2 (Week #2; Monday): Conditions: Well A; Flow Rate = 25 gpm; Ozone Dose = 45 mg/L per contactor; H_2O_2 Dose = 13.5 mg/L per contactor

After all the samples from test #1 are taken (approximately 5:00 PM), the hydrogen peroxide flowrate to each contactor will be set at 64 mg/L, which translates into a hydrogen peroxide dose of 13.5 mg/L. The ozone generator will be set to produce 188 mg/L ozone in the gas-phase, which translates into an applied ozone dose of 45 mg/L to each contactor (water flowrate = 25 gpm, and gas flowrate = 0.8 scfm to each contactor). After 30 minutes, the ozone concentration in the feed-gas will be analyzed to confirm that the target dose is achieved. Adjustments, if necessary, will be made to the ozone generator setting, and the ozone gas-phase concentration will be rechecked until the target ozone dose is reached. The system will then be left to run overnight.

At 8:00 AM on Tuesday morning, the ozone generator setting, the hydrogen peroxide feed rate, and the water flow rate will be checked and recorded to ensure that they have not changed overnight. Water samples will then be collected from the effluent of each contactor, and from five taps along the water depth of the first contactor, and analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors should analyzed for ozone gas-phase concentration to record the applied and transferred ozone dose.

The samples should be collected before 10:00 AM on Tuesday, and the system will then be setup for Test #3.

2.2.3: Test #3 (Week #2; Tuesday): Conditions: Well A; Flow Rate = 25 gpm; Ozone Dose = 60 mg/L per contactor; H_2O_2 Dose = 18 mg/L per contactor

After the samples from Test #2 are taken (10:00 AM), the ozone gas-phase concentration will be set at 250 mg/L ± 25 mg/L (which translates into an applied ozone dose of 60 mg/L ± 6 mg/L), and the hydrogen peroxide flowrate set at 85 mL/min, which translates into a hydorgen peroxide dose of 18 mg/L. At 10:30 AM, the concentration of ozone in the feed gas will be measured. If the applied ozone dose is not 60 mg/L ± 6 mg/L, then the ozone generator will be adjusted and rechecked after period of 15 minutes. This process will be repeated until the dose is within this acceptable range. The system is then allowed to reach steady-state conditions. This should be reached within four hours. While waiting for steady-state conditions to be reached, 4 influent samples will be collected from the surge tank and analyzed for explosives concentrations.

After steady-state conditions are reached, samples will be collected from the effluent of each of the six contactors, as well as from five taps along the water depth of the first contactor. The samples will then be analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors will then be analyzed for ozone gas-phase concentration. It is anticipated that the off-gas ozone concentrations will be different between the six contactors, and therefore it is important that they be measured individually.

2.2.4: Test #4 (Week #2; Tuesday): Conditions: Well A; Flow Rate = 15 gpm; Ozone Dose = 75 mg/L per contactor; H_2O_2 Dose = 22.5 mg/L per contactor

After all the samples from test #3 are taken (approximately 5:00 PM), the hydrogen peroxide flowrate to each contactor will be set at 64 mg/L, which translates into a hydrogen peroxide dose of 22.5 mg/L. The ozone generator will be set to produce 188 mg/L ozone in the gas-phase, which translates into an applied ozone dose of 75 mg/L to each contactor (water flowrate = 15 gpm, and gas flowrate = 0.8 scfm to each contactor). After 30 minutes, the ozone concentration in the feed-gas will be analyzed to confirm that the target dose is achieved. Adjustments, if necessary, will be made to the ozone generator setting, and the ozone gas-phase concentration will be rechecked until the target ozone dose is reached. The system will then be left to run overnight. It is noted that a total of 7 hours of operation time is required before steady-state conditions are reached for a flowrate of 15 gpm.

At 8:00 AM on Wednesday morning, the ozone generator setting, the hydrogen peroxide feed rate, and the water flow rate will be checked and recorded to ensure that they have not changed overnight. Water samples will then be collected from the effluent of each contactor, and from five taps along the water depth of the first contactor, and analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors should analyzed for ozone gas-phase concentration to record the applied and transferred ozone dose.

The samples should be collected before 10:00 AM on Wednesday, and the system will then be setup for Test #5.

2.2.5: Test #5 (Week #2; Wednesday): Conditions: Well B; Flow Rate = 25 gpm; Ozone Dose = 30 mg/L per contactor; H_2O_2 Dose = 9 mg/L per contactor

After Test #4 samples were taken (before 10:00 AM), the feed water will be switched to well B, and the flow rate through the system will be set at 25 gpm. The ozone generator will then be set to produce an applied dose of 30 mg/L, and the hydrogen peroxide flowrate to each contactor set at 42.3 mL/min which translates into a hydrogen peroxide dose of 9 mg/L to each contactor. At 10:30 AM the concentration of ozone in the feed gas will be measured. If the applied ozone dose is not 30 mg/L ± 3 mg/L, then the ozone generator will be adjusted and rechecked after period of 15 minutes. This process will be repeated until the dose is within this acceptable range. For a water flowrate of 25 gpm, and a gas flowrate of 0.8 scfm, a ozone gas-phase concentration of 125 mg/L will result in the target applied ozone dose of 30 mg/L to each contactor.

Steady-state conditions are expected to be reached in 4 hours of operating time. While waiting for steady-state conditions to be reached, 4 influent samples will be collected from the surge tank and analyzed for explosives concentrations.

After steady-state conditions are reached, samples will be collected from the effluent of each of the six contactors, as well as from five taps along the water depth of the first contactor. The samples will then be analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors will then be analyzed for ozone gas-phase concentration. It is anticipated that the off-gas ozone concentrations will be different between the six contactors, and therefore it is important that they be measured individually.

2.2.6: Test #6 (Week #2; Wednesday): Conditions: Well B; Flow Rate = 25 gpm; Ozone Dose = 45 mg/L per contactor; H_2O_2 Dose = 13.5 mg/L per contactor

After all the samples from test #5 are taken (approximately 5:00 PM), the hydrogen peroxide flowrate to each contactor will be set at 64 mg/L, which translates into a hydrogen peroxide dose of 13.5 mg/L. The ozone generator will be set to produce 188 mg/L ozone in the gas-phase, which translates into an applied ozone dose of 45 mg/L to each contactor (water flowrate = 25 gpm, and gas flowrate = 0.8 scfm to each contactor). After 30 minutes, the ozone concentration in the feed-gas will be analyzed to confirm that the target dose is achieved. Adjustments, if necessary, will be made to the ozone generator setting, and the ozone gas-phase concentration will be rechecked until the target ozone dose is reached. The system will then be left to run overnight.

At 8:00 AM on Tuesday morning, the ozone generator setting, the hydrogen peroxide feed rate, and the water flow rate will be checked and recorded to ensure that they have not changed overnight. Water samples will then be collected from the effluent of each contactor, and from five taps along the water depth of the first contactor, and analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors should analyzed for ozone gas-phase concentration to record the applied and transferred ozone dose.

The samples should be collected before 10:00 AM on Thursday, and the system will then be setup for Test #7.

2.2.7: Test #7 (Week #2; Thursday): Conditions: Well B; Flow Rate = 25 gpm; Ozone Dose = 60 mg/L per contactor; H_2O_2 Dose = 18 mg/L per contactor

After the samples from Test #6 are taken (10:00 AM), the ozone gas-phase concentration will be set at 250 mg/L ± 25 mg/L (which translates into an applied ozone dose of 60 mg/L ± 6 mg/L), and the hydrogen peroxide flowrate set at 85 mL/min, which translates into a hydorgen peroxide dose of 18 mg/L. At 10:30 AM, the concentration of ozone in the feed gas will be measured. If the applied ozone dose is not 60 mg/L ± 6 mg/L, then the ozone generator will be adjusted and rechecked after period of 15 minutes. This process will be repeated until the dose is within this acceptable range. The system is then allowed to reach steady-state conditions. This should be reached within four hours. While waiting for steady-state conditions to be reached, 4 influent samples will be collected from the surge tank and analyzed for explosives concentrations.

After steady-state conditions are reached, samples will be collected from the effluent of each of the six contactors, as well as from five taps along the water depth of the first contactor. The samples will then be analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors will then be analyzed for ozone gas-phase concentration. It is anticipated that the off-gas ozone concentrations will be different between the six contactors, and therefore it is important that they be measured individually.

2.2.8: Test #8 (Week #2; Thursday): Conditions: Well B; Flow Rate = 15 gpm; Ozone Dose = 75 mg/L per contactor; H_2O_2 Dose = 22.5 mg/L per contactor

After all the samples from test #7 are taken (approximately 5:00 PM), the hydrogen peroxide flowrate to each contactor will be set at 64 mg/L, which translates into a hydrogen peroxide dose of 22.5 mg/L. The ozone generator will be set to produce 188 mg/L ozone in the gas-phase, which translates into an applied ozone dose of 75 mg/L to each contactor (water flowrate = 15 gpm, and gas flowrate = 0.8 scfm to each contactor). After 30 minutes, the ozone concentration in the feed-gas will be analyzed to confirm that the target dose is achieved. Adjustments, if necessary, will be made to the ozone generator setting, and the ozone gas-phase concentration will be rechecked until the target ozone dose is reached. The system will then be left to run overnight. It is noted that a total of 7 hours of operation time is required before steady-state conditions are reached for a flowrate of 15 gpm.

At 8:00 AM on Friday morning, the ozone generator setting, the hydrogen peroxide feed rate, and the water flow rate will be checked and recorded to ensure that they have not changed overnight. Water samples will then be collected from the effluent of each contactor, and from five taps along the water depth of the first contactor, and analyzed for ozone residual and explosives concentrations. The feed-gas and the off-gas from each of the six contactors should analyzed for ozone gas-phase concentration to record the applied and transferred ozone dose. After all samples are taken, the system will be shut down.

Based on the above discussion, a total of 104 explosives samples will be collected during the Process Optimization task. Table 2 shows a breakdown of the explosives sampling schedule during this task.

Table 2

Explosives Sampling Schedule During Process Optimization Testing

Test #	Day	Influent	Contactor Effluent	Taps Along 1st Contactor Depth	Total
1	Mon.	4	6	5	15
2	Mon./Tues.	—	6	5	11
3	Tues.	4	6	5	15
4	Tues./Wed.	—	6	5	11
5	Wed.	4	6	5	15
6	Wed./Thurs.	—	6	5	11
7	Thurs.	4	6	5	15
8	Thurs./Fri.	—	6	5	11
TOTAL		**16**	**48**	**40**	**104**

Important Note: The schedule for conducting Task 2 (Process Optimization) is very compact, and does not allow for any interruptions to the plant operation. Unfortunately, it is Montgomery Watson's experience with similar projects that interruptions can occur. In order to keep the project on schedule, if interruptions do take place, optimization will be conducted on one well only. However, both wells will still be evaluated in Task 3 (System Demonstration).

2.3: TASK 3—CONDUCT SYSTEM DEMONSTRATION

During this 10-week task, the plant will be operated under constant ozone and hydrogen peroxide doses and water flow rate for a period of three weeks with each of the three wells. The exact operating conditions, such as ozone dose, hydrogen peroxide dose, and water flowrate, will be determined based on the results of Task 2 (Process Optimization Task). The selected operating conditions will be those that result in the removal of the contaminants to their corresponding target finished water levels at the lowest possible treatment cost. The plant will be operated five days a week, 24 hours per day, but will be attended for only 8 hours/day.

In addition, two tracer tests will be conducted at different days during this task. The objective of the tracer tests is to characterize the hydraulic behavior of the system and assess the degree of mixing taking place in the contactors. This information will be used to determine whether packing material will be necessary in the 1000-gpm full-scale plant.

2.3.1: Plant Demonstration

During the plant operation, the sampling schedule detailed in Table 3 will be implemented during each 5-week period for each of the two wells to be tested. It is noted that ORP stands for Oxidation Reduction Potential which will be measured online using ORP probes. The analytical results obtained from this task will be logged into the data logsheet shown in Figures 7.a and 7.b for countercurrent (downflow) and co-current (upflow) operation, respectively. However, it is noted that the plant will be operated in the countercurrent mode, unless otherwise decided during the first project progress meeting.

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEETS

TASK 3 - SYSTEM DEMONSTRATION

TEST CONDITIONS:		OZONE :		HYDROGEN PEROXIDE:		
DATE:		TARGET APPLIED OZONE (mg/L):		TARGET H_2O_2 DOSE (mg/L):		
WELL CODE:		FEED-GAS OZONE CONC (mg/L):		H_2O_2 FEED FLOW RATE (mL/min):		
ATER FLOW RATE (gpm):		FEED-GAS FLOW RATE (scfm):		H_2O_2 FEED TANK CONC (mg/L):		Verification Time
CONTACTOR FLOW (UP/I	DOWNFLOW					

SAMPLE LOCATION CODE	SAMPLE TIME	OZONE RESIDUAL (mg/L) 4/D	OZONE RESIDUAL 2 (optional) (mg/L)	pH 2/D (D INF)	ORP 2/D (D INF)	OZONE OFF-GAS CONC (mg/L) 2/D	TRANSFERRED OZONE DOSE (mg/L) 2/D	H_2O_2 'EED RAT. (mL/min) D	H_2O_2 DOSE (mg/L) D	CONTAMINANTS SAMPLE CODE D (2/W INF, W GAC1,2)	MISC. SAMPLE CODE W
INF										03-00-INF-____	03-00-INF-________-MIS
C1/0										03-00-C1/0-____	
C1/0										03-00-C1/0-____	
C1/0										03-00-C1/0-____	
C1/0										03-00-C1/0-____	
C2/0										03-00-C2/0-____	
C2/0										03-00-C2/0-____	
C2/0										03-00-C2/0-____	
C2/0										03-00-C2/0-____	
C3/0										03-00-C3/0-____	
C3/0										03-00-C3/0-____	
C3/0										03-00-C3/0-____	
C3/0										03-00-C3/0-____	
C4/0										03-00-C4/0-____	
C4/0										03-00-C4/0-____	
C4/0										03-00-C4/0-____	
C4/0										03-00-C4/0-____	
C5/0										03-00-C5/0-____	
C5/0										03-00-C5/0-____	
C5/0										03-00-C5/0-____	
C5/0										03-00-C5/0-____	
C6/0										03-00-C6/0-____	03-00-C6/0-________-M
C6/0										03-00-C6/0-____	03-00-C6/0-________-M
C6/0										03-00-C6/0-____	03-00-C6/0-________-M
C6/0										03-00-C6/0-____	03-00-C6/0-________-M
C6/0UQ										03-00-C6/0UQ-____	
C6/0UQ										03-00-C6/0UQ-____	
C6/0UQ										03-00-C6/0UQ-____	
C6/0UQ										03-00-C6/0UQ-____	
GAC3										03-00-GAC3-____	03-00-GAC3-________-M
GAC3										03-00-GAC3-____	03-00-GAC3-________-M
GAC3										03-00-GAC3-____	03-00-GAC3-________-M
GAC3										03-00-GAC3-____	03-00-GAC3-________-M
GAC1										03-00-GAC1-____	
GAC2										03-00-GAC2-____	

Note: Form of Sample Location ID for Task 3 is location code followed by "W" and well identifier, e.g. C1/0W1.

FIGURE 7a

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEETS

TASK 3 - SYSTEM DEMONSTRATION

TEST CONDITIONS:		OZONE :		HYDROGEN PEROXIDE:		
DATE:		TARGET APPLIED OZONE (mg/L):		TARGET H_2O_2 DOSE (mg/L):		
WELL CODE:		FEED-GAS OZONE CONC (mg/L):		H_2O_2 FEED FLOW RATE (mL/min):		
ATER FLOW RATE (gpm):		FEED-GAS FLOW RATE (scfm):		H_2O_2 FEED TANK CONC (mg/L):		Verification Time
CONTACTOR FLOW (UP/I	UPFLOW					

SAMPLE LOCATION CODE	SAMPLE TIME	OZONE RESIDUAL (mg/L) 4/D	OZONE RESIDUAL 2 (optional) (mg/L)	pH 2/D (D INF)	ORP 2/D (D INF)	OZONE OFF-GAS CONC (mg/L) 2/D	TRANSFERRED OZONE DOSE (mg/L) 2/D	H_2O_2 'EED RAT (mL/min) D	H_2O_2 DOSE (mg/L) D	CONTAMINANTS SAMPLE CODE D (2/W INF, W GAC1,2)	MISC. SAMPLE CODE W
INF										03-00-INF-___	03-00-INF-___-MIS
C1/UF										03-00-C1/UF-___	
C1/UF										03-00-C1/UF-___	
C1/UF										03-00-C1/UF-___	
C1/UF										03-00-C1/UF-___	
C2/UF										03-00-C2/UF-___	
C2/UF										03-00-C2/UF-___	
C2/UF										03-00-C2/UF-___	
C2/UF										03-00-C2/UF-___	
C3/UF										03-00-C3/UF-___	
C3/UF										03-00-C3/UF-___	
C3/UF										03-00-C3/UF-___	
C3/UF										03-00-C3/UF-___	
C4/UF										03-00-C4/UF-___	
C4/UF										03-00-C4/UF-___	
C4/UF										03-00-C4/UF-___	
C4/UF										03-00-C4/UF-___	
C5/UF										03-00-C5/UF-___	
C5/UF										03-00-C5/UF-___	
C5/UF										03-00-C5/UF-___	
C5/UF										03-00-C5/UF-___	
C6/UF										03-00-C6/UF-___	03-00-C6/UF-___-M
C6/UF										03-00-C6/UF-___	03-00-C6/UF-___-M
C6/UF										03-00-C6/UF-___	03-00-C6/UF-___-M
C6/UF										03-00-C6/UF-___	03-00-C6/UF-___-M
C6/UFUQ										03-00-C6/UFUQ-___	
C6/UFUQ										03-00-C6/UFUQ-___	
C6/UFUQ										03-00-C6/UFUQ-___	
C6/UFUQ										03-00-C6/UFUQ-___	
GAC3										03-00-GAC3-___	03-00-GAC3-___-M
GAC3										03-00-GAC3-___	03-00-GAC3-___-M
GAC3										03-00-GAC3-___	03-00-GAC3-___-M
GAC3										03-00-GAC3-___	03-00-GAC3-___-M
GAC1										03-00-GAC1-___	
GAC2										03-00-GAC2-___	

Note: Form of Sample Location ID for Task 3 is location code followed by "W" and well identifier, e.g. C1/0W1.

FIGURE 7b

Table 3

Sampling Schedule During Task 3 (System Demonstration)

Sampling Location		Analyte				
ID	Description	Explosives	O_3 Res.	pH/ORP	Doses	Misc.
INF—<well#>	Influent to Treatment System	2/W	—	D	—	W
C1—<well#>	Effluent of 1st Contactor	D	4/D	2/D	2/D	
C2—<well#>	Effluent of 2nd Contactor	D	4/D	2/D	2/D	
C3—<well#>	Effluent of 3rd Contactor	D	4/D	2/D	2/D	
C4—<well#>	Effluent of 4th Contactor	D	4/D	2/D	2/D	
C5—<well#>	Effluent of 5th Contactor	D	4/D	2/D	2/D	
C6—<well#>	Effluent of 6th Contactor	D	4/D	2/D	2/D	W
GAC1—<well#>	Effluent of 1st GAC Contactor	W	D	D	—	
GAC2—<well#>	Effluent of 2nd GAC Contactor	W	D	D	—	
GAC3—<well#>	Effluent of 3rd GAC Contactor	D	D	D	—	W

D = Sample collected once per day
W = Sample collected once per week
#/D = Sample collected # times per day
#/W = Sample collected # times per week
Misc.: General Mineral which includes TOC, turbidity, alkalinity, hardness, TDS, calcium, magnesium, iron, & manganese.
Doses: Includes transferred ozone dose and hydrogen peroxide dose to each contactor.
Note: The well number notation on each sample identifies the groundwater source that was being tested when the sample was taken.

2.3.2: Tracer Testing

Both tracer tests will be conducted on the first contactor only. Water should be running for at least three (3) detention times at the test flow rate BEFORE the tracer is injected into the influent line. Tracer tests will be conducted using sodium fluoride, and will use the "pulse" or "slug" feed method. In other words, a pre-calculated mass of the tracer will be injected at time "zero" into the influent line to the first contactor. The injection period should be less than 10 seconds. Samples will then be taken at 5-minute intervals from the effluent of the first contactor, as well as from five taps along the depth of the contactor. The samples are then analyzed for fluoride concentration using a fluoride-selective probe. During this period, influent water samples should be collected from the raw water surge tank every 15 minutes and analyzed for background fluoride concentration. The analytical results obtained from the tracer tests will be logged into the data logsheet shown in Figure 8. The test will be conducted at two different days during the 10-week System Demonstration task.

It is anticipated that the fluoride concentration at the effluent of the 1st contactor will reach background levels within the 3-HRT sampling period. If the effluent tracer concentration is still higher than background after the 3-HRT sampling period, sampling should be continued for an additional hour.

PEROXONE GROUNDWATER TREATMENT PROJECT

DATA LOGSHEETS

TRACER TESTING

TEST CONDITIONS:

DATE:	
WELL CODE:	
ATER FLOW RATE (gpm):	
CK VOLUME INJECTED:	
OCK CONCENTRATION:	
TRACER DOSE (mg):	
ACER INJECTION TIME:	

CALIBRATION DATA:

Fluoride Conc. (m	Probe Output (mV

Calibration Results

SLOPE	INTERCEPT
r^2 =	

Sample ID/Location	Time	FLUORIDE READOUT (mV)	FLUORIDE (mg/L)	INF. SAMPLE (Sample Every 15 Minutes)	FLUORIDE READOUT (mV)	FLUORIDE (mg/L)

FIGURE 8

2.4: ANALYTICAL METHODS

Five analyses will be conducted by the Montgomery Watson operators: ozone residual, pH, ORP, hydrogen peroxide, and fluoride tracer concentration measurements. All other analyses will be conducted by the independent evaluator using an on-site laboratory. Those analyses include all target contaminants, and general mineral constituents of the water including TOC, turbidity, alkalinity, hardness, calcium, magnesium, TDS, iron, and manganese.

A HACH CEL/700 portable analyzer will be used to measure the ozone residual concentration, the pH of the water, and fluoride concentration. A bench-top ORION meter with an ORP probe will be used to measure the ORP of the water samples collected during plant operation. The hydrogen peroxide concentration will be measured using the Cobalt method.

2.5: H_2O_2 FEED STOCK SOLUTION PREPARATION

A day tank will be used as the feed reservoir for hydrogen peroxide. The target concentration of hydrogen peroxide in the day tank is 2%, or 20,000 mg/L. This solution will be prepared from a commercial hydrogen peroxide stock solution, which has an approximate concentration of 35%, or 350,000 mg/L. The hydrogen peroxide will be diluted from 35% to 2% using deionized water. A deionized water system will be provided with the demonstration plant. The DI system should use tap water as its influent water source. To determine the exact dilution ratio to get the target 2% concentration, the exact stock solution concentration should first be measured. This is done by creating several dilutions of the stock solution and measuring their concentrations using the Cobalt method. After the day tank solution is prepared, its exact H_2O_2 concentration should be measured and recorded. The H_2O_2 flowrate to each contactor will then be adjusted to provide the target dose based on the feed tank concentration.

The stability of the H_2O_2 stock solution and the day tank feed solution is of concern. Therefore, the following measures should be implemented at all times:

1. The H_2O_2 stock solution should be stored in the dark at 4°C when not in use.
2. The day tank should be covered and protected from any sunlight.
3. The H_2O_2 concentrations in the stock solution and in the day tank should be checked evertime the day tank feed solution is prepared.
4. The stability of the H_2O_2 feed solution strenght in the feed day tank should be checked during a 24 hour period to ensure that the concentration of H_2O_2 does not change between preparation times. This test is done by measuring the feed solution strength at different times during the day.

2.6: SAMPLE IDENTIFICATION

A standard notation should be used for all water quality samples provided to the independent evaluator for analysis. The notation should include the following parts:

1. Task Number
2. Test Number (if applicable)
3. Tap Code
4. Time & Date

For example, a sample collected from the effluent of the second contactor (tap C2/0) during Test #3 of Task #2 (Process Optimization task) at 2:15 PM on August 17 will have the notation:

02—03—C2/0—14150817

If no test number exists (e.g., during the 10-week demonstration period [Task #3]), the test number should be substituted with "00". Labels for all samples collected for immediate analysis by the operators should, at a minimum, include the tap letter-code.

To satisfy a 10% QA/QC requirement, one sample from the effluent of the 6th contactor will be collected in duplicates every week. The ID for these samples should have a notation at the end to show that they are duplicates. For example, the following identifiers are for duplicate samples collected from the effluent of the 6th contactor at 3:10 PM on September 12:

03—00—C6/0—15100912—D1
03—00—C6/0—15100912—D2

Appendix F

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