OPERATION AND MAINTENANCE MANUAL
MOBILE AQUIFER AIR SPARGING SYSTEM

Prepared For:

U.S. Army Environmental Command

FORT DRUM, NEW YORK

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LIST OF ACRONYMS

AAFES	Army Air Force Exchange Service
AAS	Aquifer Air Sparging
ACA	Army Contracting Agency
CO_2	Carbon Dioxide
DPE	Duel-Phase Extraction
FSP	Field Sampling Plan
g/hour	Gallons per hour
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
H_2O	Water
ISCO	In-Situ Chemical Oxidation
ISOC	In-Situ Oxidation Compound
KVA	K-V Associates
LNAPL	Light Non-Aqueous Phase Liquids
L/min	Liters per minute
mg/L	Milligrams per liter
MPE	Multi-Phase Extraction
O1	Oxygen atom
O2	Diatomic oxygen
O3	Ozone
O&M	Operations and Maintenance
Plexus	Plexus Scientific Corporation
ppm	Parts per million
psig	Pounds per Square Inch Gravity
PVC	Poly-Vinyl Chloride
SVE	Soil Vapor Extraction
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1 INTRODUCTION

1.1. PROJECT DESCRIPTION

The U.S. Army Contracting Agency (ACA), Aberdeen Proving Ground Directorate of Contracting, has selected Plexus Scientific Corporation (Plexus) to provide supervision, labor, and materials to provide environmental remediation services at Fort Drum Military Reservation under contract W91ZLK-05-D-011, Task Order 004. This Operations and Maintenance (O&M) Manual provides guidance for the trailer mounted ozone in-situ oxidation compound (ISOC) treatment system formerly located at the Army Air Force Exchange Service (AAFES) Station, Building P-2140. The trailer mounted ozone system is to be mobilized as part of the Source Area Remediation Action, Gasoline Alley, Fort Drum, New York.

1.1.1 Background

Fort Drum Military Reservation is located in upstate New York approximately 10 miles northeast of Watertown, 80 miles north of Syracuse, and 25 miles southeast of the U.S./Canadian border. Fort Drum occupies a large portion of northeastern Jefferson County and a portion of western Lewis County. The Reservation encompasses approximately 168 square miles.

Fort Drum was established in 1906 as a National Guard training facility. During World War II, the Reservation functioned as an operations base and firing range and provided combat skills training facilities for the 45th Infantry Division and the 4th and 5th Armored Divisions. Additionally, the Reservation conducted small amounts of explosive ordnance disposal. Currently, Fort Drum is the operations headquarters for the 10th Mountain Division (Light Infantry). The Reservation also supports training facilities and services for the US Army National Guard.

Gasoline Alley is located in the southwest corner of Fort Drum in the developed portion of the Reservation known as the old cantonment area. The 2-mile-long thoroughfare consists of two parallel one-way streets, Oneida and Ontario Avenues, and associated unpaved median located between the two avenues. Gasoline Alley is used as one of the main traffic flow paths in the Reservation. Vehicle and equipment storage and maintenance areas are located to the south of Gasoline Alley, and a rail line and coal-fired power generation plant are located to the north of Gasoline Alley.

Gasoline Alley has been used for fuel storage and dispensing at least since the 1940s when Fort Drum was expanded. Nine fuel dispensing areas were located along Gasoline Alley where kerosene, gasoline, diesel fuel and jet propulsion fuel (JP-4) were stored and dispensed from 22 underground storage tanks (USTs) ranging in capacity size from 5,000 to 25,000 gallons. The dispensing areas are referred to as Areas 1195, 1295, 1395, 1495, 1595, 1795, 1895, 1995, and 3805. The USTs, fuel dispensers, and associated piping were removed in 1994 and 1995.

Previous investigations indicated that an extensive light non-aqueous phase liquid (LNAPL) plume exists in the vicinity of the former UST areas between Oneida and Ontario Avenues on Fort Drum.

The results of these investigations are summarized in the Final Corrective Measures Studies (EA, 2003; EA, 2004; Malcolm Pirnie, 2005) and Comprehensive Contaminant Assessment Report Volume I through V (EA, 1998; EA, 1999).).

Subsequently, active remediation systems consisting of aquifer air sparging (AAS), dual-phase extraction (DPE), multi-phase extraction (MPE), and soil vapor extraction (SVE) were designed and installed within areas in which USTs were removed (Areas 1395, 1495, 1595, 1795, 1895/3805, and 1995). Recovery data indicates that during the first year of system operations, mass removal of contaminants was approximately 50% of the total volume removed over a three year period. The most recent year of operations has yielded a recovery of approximately 8% of the total mass removed. Decreasing contaminant concentrations, groundwater table elevation changes and system limitations may be the leading causes of low recovery performance. As a result, the areas may be at an equilibrium in which a final polishing technology may act to actively oxidize the contaminants as well as provide an alternate oxygen source to augment the continuous natural biological activity and move the sites into post-remedial activities.

1.1.2 Objective

This O&M Manual is intended to serve as a general guide to personnel operating the trailer mounted aquifer air sparging with ozone system at sites within the Military Reservation Boundaries of Fort Drum. The information contained within this O&M Manual should be used in conjunction with the manufacturers' information and recommendations included in the appendices. In addition, this O&M Manual does not describe specific O&M functions in detail but rather identifies normal operating procedures.

1.2 PERSONNEL REQUIREMENTS AND EMERGENCY CONTACTS

It is anticipated that a technician will be onsite on a daily basis in order to collect monitoring data and perform preventive maintenance. Prior to performing work onsite, operating personnel should thoroughly review and be familiar with emergency procedures outlined in the Health and Safety Plan.

1.3 MANUAL ORGANIZATION

This O&M Manual describes the function and O&M of each major component of the trailer mounted Ozone system.

This O&M Manual is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Process and Equipment Description
- Section 3 – System Operations and Monitoring
- Section 4 – System Maintenance
- Section 5 – Emergency Response
- Section 6 – Reporting

2 PROCESS AND EQUIPMENT DESCRIPTION

The remedial system described in this O&M Manual was installed and operated at Area P-2140 in January 2001. Following completion of treatment at Area P-2140, the remedial system was transferred from a building to a trailer mounted system for application at other areas.

OZONE INJECTION

2.1 Technology Overview

In-situ chemical oxidation (ISCO) is the injection of liquid or gas into the subsurface that causes oxidation and can result in the direct destruction of petroleum contamination. This process can also result in the indirect decrease of petroleum contamination by increasing the dissolved oxygen content in groundwater, which enhances biodegradation.

Ozone (O_3) is an allotrope of oxygen, consisting of three oxygen atoms that are less stable than diatomic oxygen (O_2). Ozone is more soluble than oxygen in water and has been used for decades in municipal water treatment applications for disinfectant purposes. However, the use of ozone as an ISCO compound for soil and groundwater remediation projects has increased over the last several years as an alternative remedial method. There are two distinct forms of in-situ ozone application: vadose zone injection of ozone gas and ozone sparging below the water table.

In general, ozone based process for site remediation is similar to other chemical oxidation techniques in that the oxidant of choice is injected into the desired treatment area. However, the use of ozone is different from most oxidation processes as the ozone (O_3) can be injected as a gas or liquid (as ozonated water). This approach provides the opportunity to deliver more continuous oxidation as opposed to batch applications typically associated with other techniques.

When an ozone (O_3) molecule comes in contact with a volatile organic compound (VOC) molecule, the ozone reacts with the contaminant producing innocuous substances such as carbon dioxide (CO_2) and water (H_2O). Examples of contaminant chemical reactions are given below:

Benzene: $C_6H_6 + 11\ O_3 \rightarrow 6C0_2 + 3\ H_2O + 11\ O_2$.
Toluene: $C_6H_5CH_3$.+ $18\ O_3 \rightarrow 7\ CO_2 + 4\ H_2O + 18\ O_2$
Ethylbenzene: $C_8H_{10} + 9\ O_3 \rightarrow 8\ CO_2 + 5\ H_2O + 3\ O_2$
Xylene: $C_6H_4(CH_3)_2 + 21\ O_3 \rightarrow 8\ CO_2 + 5\ H_2O + 21\ O_2$
Perchloroethylene (PCE): $CCL_2CCL_2 + 6\ O_3 \rightarrow 2\ CO_2 + 2\ CL_2O + 6\ O_2$
Trichloroethylene(TCE): $2\ CHCLCCL_2 + 12\ O_3 \rightarrow 4\ CO_2 + H_2O + 3\ CL_2O + 12\ O_2$

Ozone (O_3) gas is formed when oxygen molecules (O_2) are exposed to a controlled high-voltage electrical field. As oxygen molecules pass through this field, a portion of the molecules are split, creating a pair of oxygen atoms (O_1). Seeking molecular stability, these atoms recombine with other oxygen molecules (O_2) in the air stream to form ozone (O_3).

2.2 Ozone Sparge Equipment

For soil and groundwater remediation application, ozone is delivered to the subsurface below the groundwater table via specialized equipment designed specifically for mobile application at multiple sites. An oxygen generator delivers 90% pure oxygen to the ozone generator after drying the air stream. The oxygen generator separates oxygen from other gases in the air and, under humid conditions, dries the air prior to feeding the ozone generator. Increasing the supply of oxygen to the ozone generator increases the output concentration of ozone. The oxygen generator is rated to run continuously, and can produce up to 5.5 liters per minute (L/min) of 90 percent oxygen at 0-9 psig. The ozone generator produces low concentrations of ozone from air or oxygen, while a booster pump injects the ozone into the sparging process air. The ozone generator can produce 4 gallons per hour (g/hour) at 5 L/minute if operating without an oxygen generator, and up to 8 g/hour with an oxygen generator. Two air compressors (two horsepower) operate in parallel and are mounted on top of the receiver tank. A pressure switch is used to regulate the pressure in the tank by turning the compressors on and off at 25 psi and 40 psi, respectively, and can be adjusted based on operational needs. The receiver tank is equipped with an automated drain valve that is discharged to a floor drain. A Hankison International 5 horsepower refrigerated air dryer prevents potential line freezing as a result of condensation. Condensate generated from the dryer is discharged to the floor drain. Health and safety concerns prompted the installation of an ozone detector. Ozone is an oxidizer and can be harmful in concentrations above 0.1 parts per million (ppm). The ozone detector allows screening of the breathing area for harmful levels of ozone, in addition to facilitating leak detection in system piping. Should ozone concentrations within the system housing unit exceed 0.1 ppm, an alarm will go off, the system will shut down, and the exhaust fan will turn on.

It is imperative that all components on the ozone side of the system are ozone compatible. Compatible materials such as stainless steel, Teflon, Kynar, Viton, and schedule 80 poly-vinyl chloride (PVC) should always be used for ozone application. High-density polyethylene (HDPE) and natural rubbers should not be utilized with ozone.

The system components include a rotary-vane air compressor with an inlet particle filter, an oxygen generator, ozone generator, two air compressors and an automated manifold system. Up to 10 different zones can be controlled through a combination of timer-operated automatic solenoid valves. The layout of the mobile AAS system is illustrated in **Figure 1**. The system components were manufactured by K-V Associates (KVA), and a schematic diagram is shown on **Figure 2**. The O&M manual for the KVA equipment is included in **Appendix A**.

2.3 Ozone Sparge Wellhead Configuration

Ozone sparging is anticipated to be used in conjunction with existing subsurface remediation systems. A sparge stinger consisting of schedule 80 PVC and other ozone compatible materials will be installed in existing sparge wells. The stinger will be constructed with a Shuma pipe (for ozone diffusion) and "K" packer seals to isolate the injection zone within the groundwater table. **Figure 3** illustrates the typical wellhead configuration.

3 SYSTEM OPERATIONS AND MONITORING

3.1 INTRODUCTION

Field operations and monitoring will be conducted on a weekly basis and include: (1) collecting system operational data (sparging flow rates and pressures), (2) gauging selected monitoring wells, and (3) collecting vadose zone pressure data and oxygen concentrations. Groundwater samples will be collected as outlined in the Field Sampling Plan (FSP) to evaluate the effectiveness of the treatment. This section will discuss start-up procedures, normal operations and monitoring requirements, emergency procedures and shut-down procedures.

3.2 START-UP

1. In the enclosure that houses the palletized C-Sparger™ make sure that the exhaust fan is on. The 230V power should already be hardwired, and the circuit breaker on.
2. Before turning on the 230V power switch, open the drain valves on the bottoms of the air storage tank and the mixing tank. Observe caution if there is already pressure in the tanks (read the tank pressure gauges first).
3. Check the air compressor function by turning on the 230V power switch. The compressors should start instantly, and air should be coming out of both bleed valves. The compressors magnetic starters contain circuit breakers (one for each pump) which may be re-set by pushing the buttons on these boxes. For emergency shut-down, turn the master switch on/off to off. If for any reason the unit continues to blow fuses and requires a circuit breaker re-set on a regular basis, a licensed electrician should be notified.
4. Turn off the bleed valve on the larger air tank first. Air should still be coming out of the mixing tank.
5. Close the bleed valve on the mixing tank. The pressure on both tanks should rise to a preset 45 psi, and then the compressors will turn off. When the pressure in the tanks reach approximately 25 psi, the compressor will turn back on.
6. Open the bleed valve on the mixing tank again. Look at the gauge on the pressure regulator. It should read a preset 45 psi. This can be adjusted by turning the valve on the pressure regulator. The compressors will restart when the pressure gets down to 25 psi.
7. Plug in the C-Sparger™ pallet 120V power into a suitable outlet.
8. Open the programmable controller's door and check the display. Change the time and date if necessary. See the instructions in the installation chapter of **Appendix A** for more details. The dial should be turned OFF at this point.
9. Plug the control panel into the 120V electrical outlet on the pallet.
10. If the air/ozone lines have been connected from the solenoid valves to the well head assemblies in the field, then the oxygen generator can be turned on at the switch on the unit. A **white** light will indicate that the unit is operational. A **red** light indicates a no flow condition, and ozone will not be generated. **The ozone generator should only be turned**

on when the air/ozone output from the system vents into a well, or to an outside space away from people. Make sure that the exhaust fan is ON. If ozone is detected at any time, immediately turn OFF the ozone generator at its switch, and clear the room if necessary.

11. Turn the dial in the programmable controller to Station 1. "Program A – Station 1 for 30 minutes" should show in the LED display. Press the MAN. START key. Solenoid valve #1 should open. Note that pressures should drop on the air tank and mixing tank. To stop the program from running at any time, turn the dial to OFF. There is a delay before everything turns off. The booster pump will turn on automatically when a valve opens. The ozone generator will also turn on if it is switched ON. See step 10 above. If the valve is left open long enough, the compressors will turn on when the pressure reaches 25 psi.
12. An abbreviated test of all stations can be achieved with the dial turned to TEST PROGRAM on the programmable controller. Set the length of time to test each station in Program A for 1 to 99 minutes with the arrow keys. Press the MAN. START key. Station 1 (solenoid valve #1) will open as programmed. Turn the dial back to OFF when finished.

3.3 NORMAL OPERATIONS AND MONITORING

As long as no upset conditions occur, the system will be running as part of normal operations after start-up. The monitoring program includes measuring air flow, sparging pressures, vadose pressures, water levels, and soil gas oxygen concentrations. These parameters are monitored on a weekly basis.

3.3.1 Flow Rates

System flow rates are measured at two locations: (1) total flow rate at the compressor discharge, and (2) individual well flow rates at the distribution vaults. Direct reading rotameters are recommended.

3.3.2 Pressure

Pressure readings are recorded at the compressor and at individual wells utilizing a magnehelic gauge. In some cases, the sparge points may already be equipped with direct reading gauges. Pressure and flow rate data can be evaluated to make adjustments to system operation.

3.3.3 Water Level Measurements

Water level measurements should be collected using either an interface probe or a water level indicator. Water level measurements should be recorded within 0.01 ft to monitor any effect the sparging system may have on the aquifer.

3.3.4 Oxygen Concentrations

Groundwater dissolved oxygen concentrations should be measured using a dissolved oxygen meter (i.e., YSI Model 57). The selected direct reading instrument should be capable of detecting dissolved oxygen concentrations to within a range of 0-25 milligrams per liter (mg/L).

3.3.5 Volatile Organic Compound Concentrations

Groundwater samples collected from site monitoring wells will be analyzed as outlined in the FSP.

3.3.6 Field Equipment Calibration and Maintenance

Prior to use, all equipment should be inspected for proper operation. The equipment should be calibrated and maintained at a frequency and under conditions per manufacturer's specifications. All manufacturer's instrumentation and equipment manuals should be available in the field for reference as needed.

3.4 EMERGENCY CONDITIONS

The emergency stop button (kill switch), located at the bottom of the main control panel, will shut down all operations if emergency conditions should arise. In case of an extreme emergency, technicians should first dial 911 and then shutdown the system. **The Project Engineer and/or Manager should be notified of any emergency system shutdowns.**

If any of the following lights on the main control panel go on the system will automatically shut down:

- high level T-1
- high level T-2

If the KVA System is running, any upset conditions from it will also shut the system down (**Appendix A**).

In the event of an emergency condition, the alarm will go off and the system will shut down. After an emergency condition occurs, push alarm silence button on main control panel. Before proceeding, identify problem and provide a solution before restarting system. When the emergency condition has been fixed, push alarm reset and repeat start-up procedures.

3.5 SHUT-DOWN PROCEDURES

1. Turn off Air Sparge Wells at main panel.
2. Turn off compressor at main panel.
3. Turn off Blowers 1 and 2 at main panel.
4. Turn off Control Power at main panel.
5. Turn off disconnect at junction box on power line.

4 SYSTEM MAINTENANCE

4.1 INTRODUCTION

The supplier recommended maintenance schedule for the major system equipment is outlined in **Appendix B**. The maintenance will be performed by Plexus personnel or subcontractor technicians as per agreements with them. The sparge air will be sampled on a monthly basis to see if the filter needs to be replaced. Any other spare parts or expendable replacements will be provided on an as needed basis.

A list of vendors for the major equipment is provided below along with the addresses, phone number, and contact people:

1. K-V Associates, Inc.
   Madaket Place, B-12
   766 Falmouth Road
   Mashpee, MA 02649
   TEL (508) 539-3002 FAX (508) 539-3566

5 EMERGENCY RESPONSE

5.1 GENERAL

Health and safety is Plexus' and the US Army Environmental Command's number one priority. Never compromise your, or another person's, safety in the process of completing a task. Unsafe conditions should be reported immediately to the Plexus Project Manager or Task Specialist.

All injuries must be reported to the Plexus office as soon as possible. Never transport a seriously injured person; call for emergency medical assistance as quickly as possible.

All Plexus personnel, including their subcontractors must read and sign the site-specific Health and Safety Plan (HASP). The HASP is located in the same waterproof container as this manual. A route to the nearest hospital/emergency medical center is outlined in the HASP. Refer to the HASP for information not included in this section.

Local Hospital Name, Number & Address **Samaritan Medical Center**
830 Washington Street
Watertown, New York
(315) 785-8469

Directions to Hospital (map attached in **Appendix C**)

1.	Start at the entrance to Fort Drum – Route 26/Great Bend Road/Garrison Lane	
2.	Proceed SOUTH on Route 26, which becomes Route 197 after exiting Fort Drum. Pass Maiden Lane.	0.2 miles
3.	Turn RIGHT onto Route 3 and proceed 10.8 miles. Route 3 becomes Rutland Street.	10.8 miles
	Cross Huntington Street into Watertown, where Route 3 becomes Eastern Boulevard.	
	Turn RIGHT to stay on Route 3/Route 12 – State Street.	
4.	Turn LEFT on Williams Street.	0.3 miles
5.	Williams Street turns slightly RIGHT and becomes Winslow Street.	0.5 miles
6.	Turn LEFT at U.S. Route 11/Washington Street. Samaritan Medical Center is located at 830 Washington Street.	0.3 miles

5.2 REPORT PROCEDURE AND DEFINITION OF AN EMERGENCY

When reporting an on-site emergency, contact the Plexus office and speak with the Project Manager or Task Specialist. Emergencies constitute any situation that threatens the health and safety of Plexus personnel and/or others, any situation that causes damage to property, any situation that detrimentally affects the US Army Environmental Command's interests or any combination of the above.

Any system-related problems such as equipment failure, vandalism, leaks or anything that has or will cause an interruption in operation should be called in to the Plexus office and reported to the Plexus Task Specialist or Project Manager, in that order.

Questions asked by retail customers or passers-by must be referred to the US Army Environmental Command. Only public authorities such as police, the NYSDEC, the EPA or local inspectors are to be allowed access or information on site. Should anyone want to inspect the system or demand information, ask them to show you some form of identification. **Always write their name(s) in your fieldbook! Always call the Plexus office immediately with this information!** Direct any person without proper identification to the US Army Environmental Command.

5.3 PHONE LIST

In the case of an emergency at any of the Fort Drum sites, use the telephone list provided in **Appendix C**.

Please consult the Health and Safety Plan, dated June 2008, for further details regarding any questions related to health or safety issues.

All individuals working on the air sparging system must sign-in with the local safety officer on site. They must document that they have read and understood the health and safety plan and have been trained in proper operation of the equipment on site.

5.4 SIGN IN SHEETS

Included in **Appendix D** of the Operation and Maintenance Manual are sign in sheets for any person visiting this mobile trailer unit. All visitors must print their name, company and the time and date of their visit. This includes Plexus employees, Fort Drum employees, Plexus or Fort Drum subcontractors and regulatory officials. If no new sheets are available, inform the Plexus Project Manager or Engineer immediately.

6 REPORTING

6.1 GENERAL

Reporting requirements for the use of the mobile Ozone ISCO Trailer will comply with the existing active remediation systems currently operating at Fort Drum. Monthly reporting of the trailer location and treatment parameters will be provided as part of the normal submittal.

7 REFERENCES

7.1 REFERENCE LIST

EA, 1998a. *Final Comprehensive Contaminant Assessment Report, Volume III, Area 1595, Gasoline Alley, Fort Drum, NY (October).*

EA, 1998b. *Final Comprehensive Contaminant Assessment Report, Volume IV, Area 1795/WWII Landfill, Gasoline Alley, Fort Drum, NY (October).*

EA, 1998c. *Final Comprehensive Contaminant Assessment Report, Volume V, Areas 1895, 1995, 3805, and Old Sanitary Landfill, Gasoline Alley, Fort Drum, NY (December).*

EA, 1999a. *Final Comprehensive Contaminant Assessment Report, Volume II, Areas 1195, 1295, 1395, and 1495, Gasoline Alley, Fort Drum, NY (August).*

EA, 1999b. *Final Comprehensive Contaminant Assessment Report, Volume I, Introduction and Overview, Gasoline Alley, Fort Drum, NY (August).*

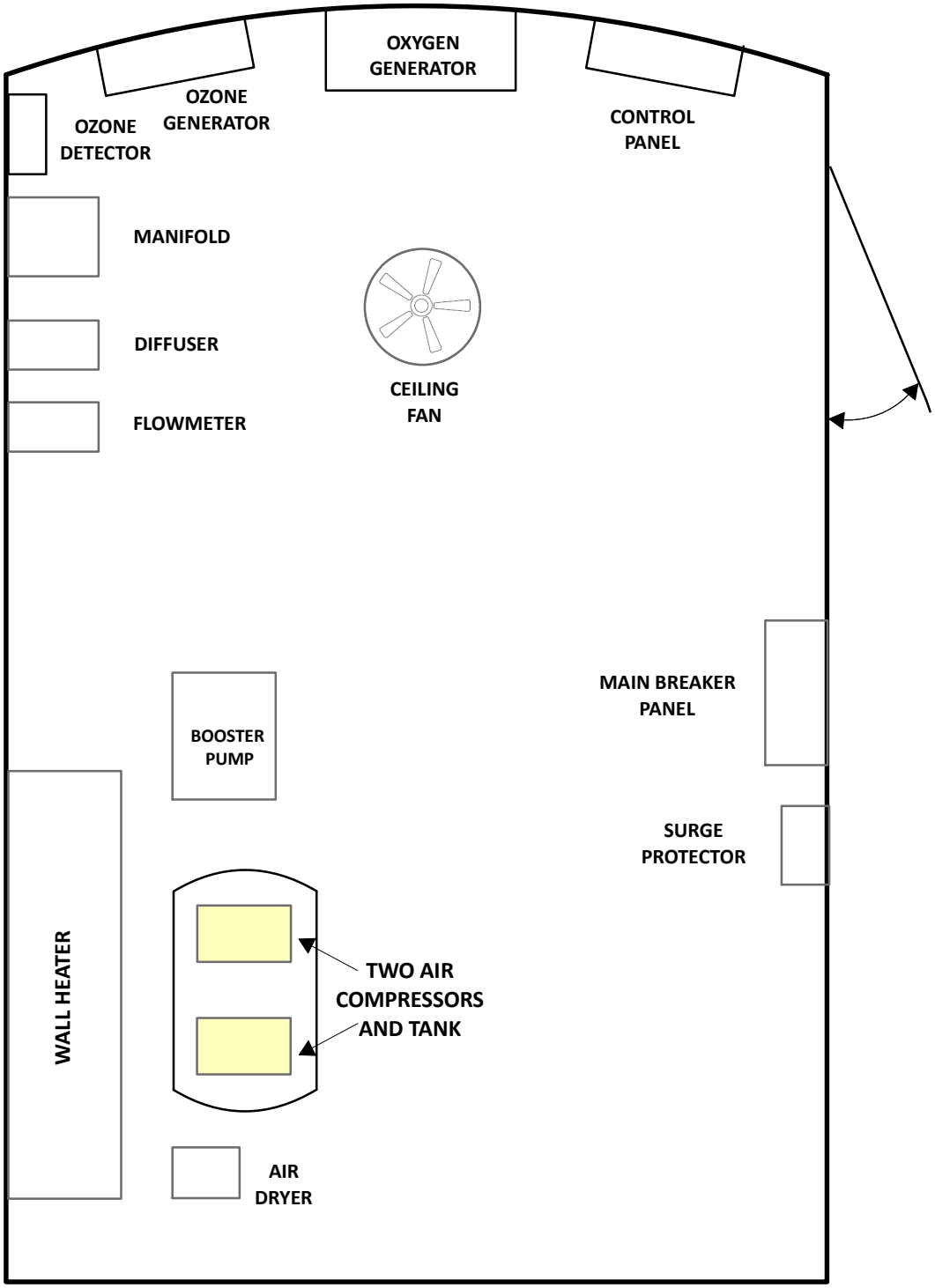
EA, 2003a. *Final Corrective Measures Study, Army Air Force Exchange Service Station, Fort Drum, NY (June).*

EA, 2003b. *Final Corrective Measures Study, Area 1595, Gasoline Alley, Fort Drum, NY (July).*

EA, 2004. *Final Corrective Measures Study, Area 1795, Gasoline Alley, Fort Drum, NY (June).*

Malcolm Pirnie, 2005. *Final Corrective Measures Study, Areas 1895, 1995, 3805 and Old Sanitary Landfill, Fort Drum Military Installation, Fort Drum, NY (December).*

FIGURES



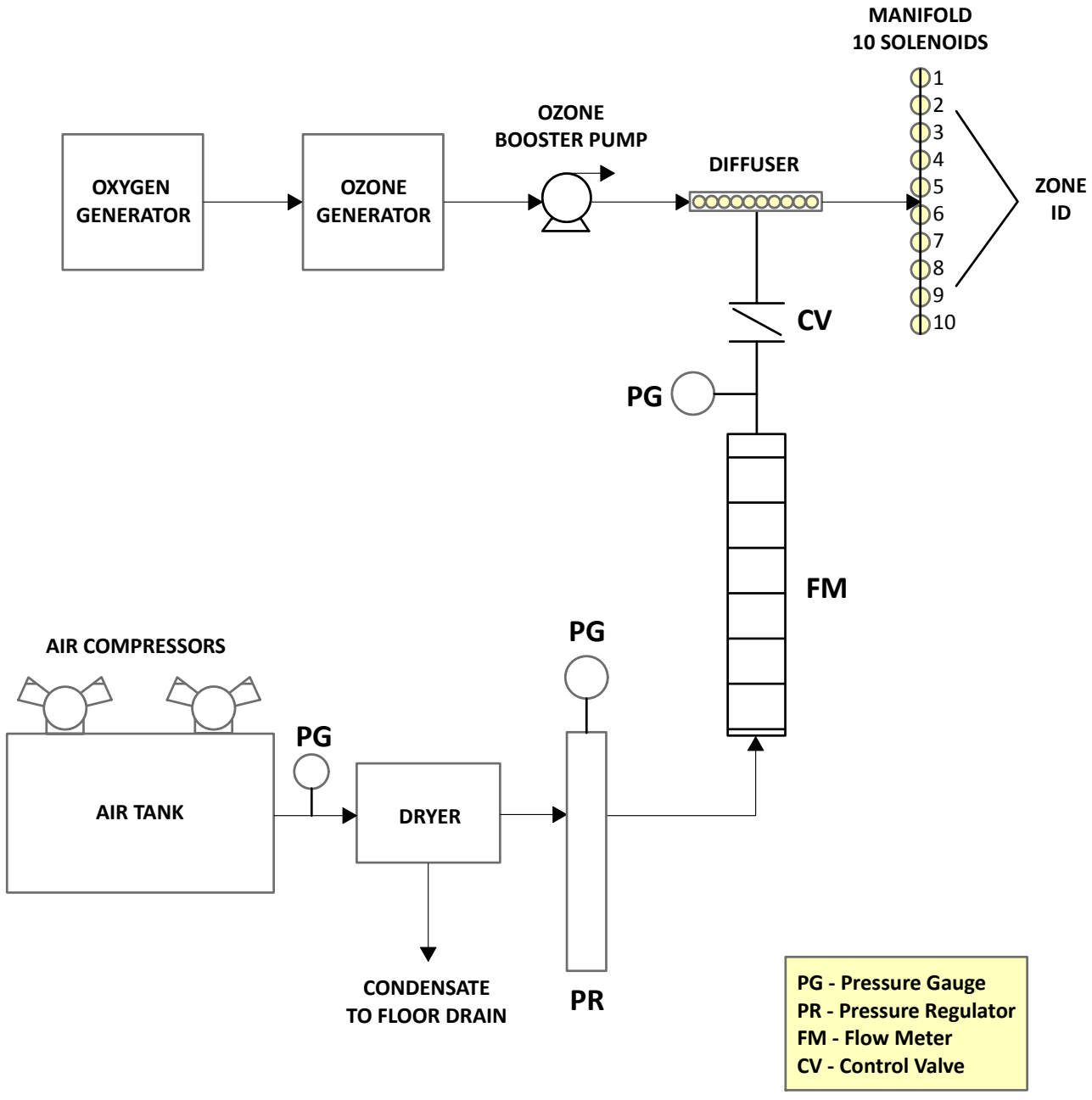
Created By: MJB Date: May, 2009	**FIGURE 1**

TREATMENT TRAILER FLOOR PLAN

OPERATION AND MAINTENANCE MANUAL
MOBILE OZONE AQUIFER
AIR SPARGING SYSTEM

PLEXUS scientific

4501 Ford Ave.
Suite 1200
Alexandria, VA 22302
(P) 703.820.3339
(F) 703.845.8568



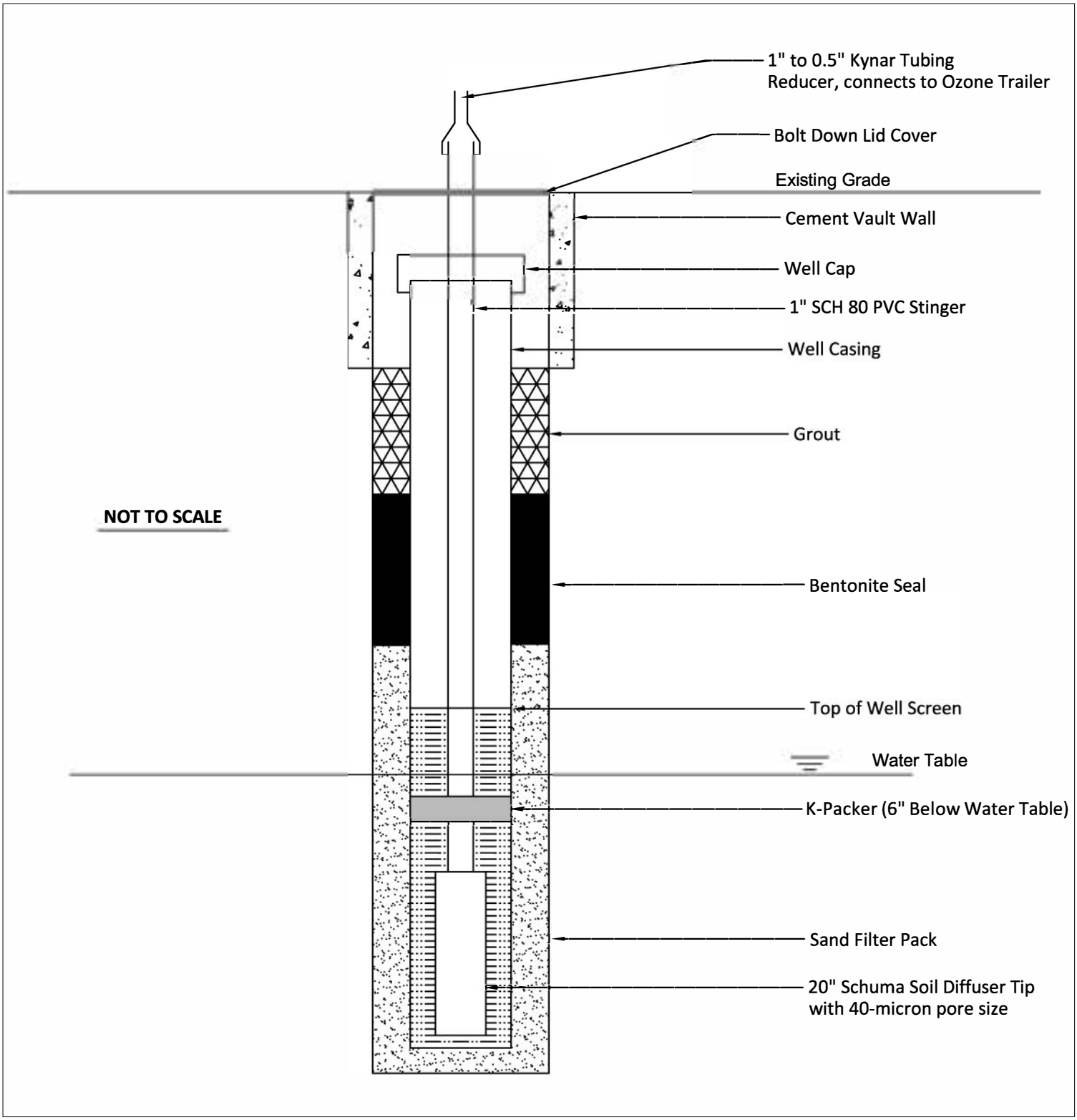
Created By: MJB Date: April 2009	**FIGURE 2**

SCHEMATIC DIAGRAM OF THE AQUIFER AIR SPARGE SYSTEM

OPERATION AND MAINTENANCE MANUAL MOBILE AQUIFER AIR SPARGE SYSTEM

PLEXUS scientific

4501 Ford Ave.
Suite 1200
Alexandria, VA 22302
(P) 703.820.3339
(F) 703.845.8568



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Created By: Alex Scott
Date: June 2009

Figure: 3

Typical Monitoring Well Diagram with Ozone Modification

Operation and Maintenance Manual
Mobile Aquifer Air Sparging System

APPENDIX A

K-V ASSOCIATES SYSTEM OPERATIONS

KVA

C-SPARGER™*

MODEL SERIES 6000

Installation & Operation Manual

Read this manual carefully before attempting to assemble, install, operate or maintain the described equipment. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage!

Retain these instructions for future reference.

KVA
K-V Associates, Inc.
Madaket Place B-12
766 Falmouth Road
Mashpee, MA 02649

Tel: (508) 539-3002
Fax: (508) 539-3566
Email: KVAssoc@aol.com

June 2000

*US Patents #5,855,775 and #6,083,407. Other US and foreign patents pending.

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INTRODUCTION

The C-Sparger™ Systems are designed to remove dissolved organics and solvents. Chlorinated unsaturated hydrocarbons such as PCE, TCE, and DCE are rapidly and effectively removed by the system while producing the breakdown products of very dilute hydrochloric acid (HCl) and carbon dioxide ($C0_2$). Dissolved aromatic ring compounds such as BTEX (benzene, toluene, ethylbenzene, xylene) commonly associated with gasoline spills are effectively stripped in situ and simultaneously decomposed, yielding the breakdown products of CO_2 and water. The first-order breakdown products of ozone, which includes dissolved oxygen, can accelerate bacterial action on the breakdown of heavier organic components commonly associated with TPH (total petroleum hydrocarbons).

The Model 6000 Series Palletized C-Sparger™ is a 20 CFM capacity air/ozone system with the ability to supply 10 recirculating double screen wells with Spargepoint® and pump assemblies. Up to 30 Spargepoints® can be operated from one palletized system. Major components of the system include a palletized programmable controller and solenoid valve system, a dual compressor system, pressure tanks, DC power supply, an ozone generator and booster pump. On a separate mounting is an oxygen generator which supplies dry O_2 to the ozone generator. The C-Sparger™ is designed to work with multiple above ground wellhead assemblies, which control flow of air/ozone and electricity to the wells, as well as allow a point of water inflation to the packers. Each well is provided with one below-well Spargepoint® and one in-well Spargepoint®. Each in-well Spargepoint® assembly consists of a dual submersible pump, a Spargepoint® and a packer.

Normal operation for C-Sparger™ Systems includes carrying out, in series for each well on a timed basis, the functions of pumping air and ozone through Spargepoints® into the soil formation, and recirculation pumping of aerated/ozonated water into the aquifer through the well. Treatment is followed by a programmed period of no external treatment, and multiple wells are sequenced in turn. Wells can either be operated in pairs or singly. The rising fine bubbles create density driven circulation beyond the area of influence of recirculation alone. Agitation with pumped water disturbs the usually inverted cone-shaped path of bubbles through the soils and disperses them much more widely. This increases contact and greatly improves efficiency and speed of remediation.

SYSTEM DESCRIPTION AND SPECIFICATIONS

The KVA Model Series 6000 C-Sparger™ consists of three parts: (1) the palletized ozone supply system with zone control, (2) the distribution tubing and individual above ground well head assemblies, and (3) the Spargepoints.

PALLETIZED OZONE SUPPLY SYSTEM

The palletized gas supply system consists of a number of components described below and shown in Figure 1. Component information and specifications are provided in Tables 1 and 2.

Compressor system

Two 2 Hp compressors are mounted on top of an air storage tank. The compressors operate in parallel to pressurize the air storage tank, although each can perform solo if necessary. The pumps operate on 230 volt single phase power, which is independent of the multi-zone control panel, and it's associated equipment. Each compressor is wired to a magnetic starter and a common 230 V power switch. A pressure switch regulates the pressure in the tank by turning on and off the compressors. Air pressure in the tank is set at KVA between 20 psi and 40 psi but can be adjusted to operate in different site characteristics. The pressure can be read from a gauge on the tank.

Multi-Zone Control Panel

The multi-zone control panel houses the programmable controller and all switches that operate the solenoid valves on the manifold, and turn on and off the gas generating equipment, which includes the ozone generator, the associated booster pump, and oxygen generator. The control panel operates on 120 Volt power.

Solenoid Valves

Solenoid valves operate in a cyclical fashion meaning only one solenoid valve will open at one time. The run times for the individual solenoid valves are programmed using the programmable controller.

Programmable Controller

A programmable controller determines the sequence and duration of the switching operations inside the control panel. Within each of four programs, the timer is capable of operating up to 16 switches, each with up to six start times and durations per day.

Figure 1. C-Sparger™ Model 6000 Series Palletized System

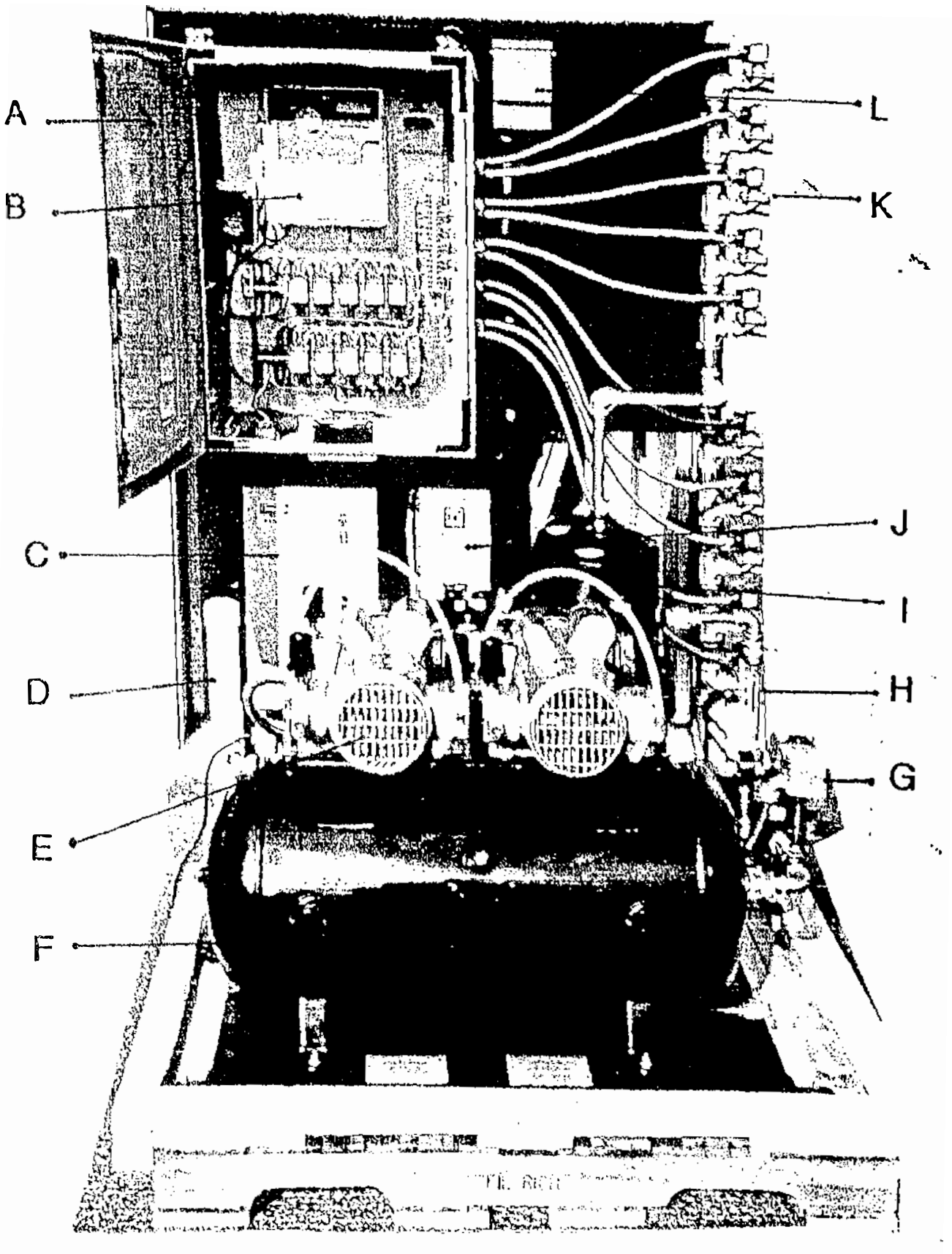


Table 1. C-Sparger™ Model 6000 Series Specifications

Component	Power Requirements	Size/Performance
C-Sparger™ Palletized System	230V single phase, 120V	500 lb, 45" wide x 33" deep x 73 " high
Air Compressors	230V, 60 Hz, 10 amp single phase	2 Hp, 100 psi max, 11 cfm open flow
Multi-Zone Control Panel	120 V, 60 Hz	30 Spargepoint (expandable)
Programmable Controller	120 V, 60 Hz, 0.6 amp	4 program, 16 station, 6 cycle
Ozone Booster Pump	115V, 60 Hz , 3.1 amp	1/8 Hp, <= 100 psi
Ozone Generator	120V, 60 Hz, 1 amp	4 g/hr at 5 l/min flow, 8g/hr with O2
Oxygen Generator	120V, 60 Hz, 4.0 amp	5.5 l/min @ 0-9 psig, 90% O2
Solenoid Valves	120 V, 60 Hz, 10 watt	0 - 100 psi
Air Pressure Tank		30 gallon horizontal tank, 200 psi max
Ozone/Air Mixing Tank		10 gallon vertical tank, 200 psi max
Spargepoint®		24" long, 2" diameter

Table 2. C-Sparger™ Series 6000 listing of Switches, Fuses and Breakers

Fuses and breakers are intended to protect equipment from serious damage. Repeated activation is a warning of possible serious problems due to equipment failure, equipment overload, extreme environmental parameters, or inappropriate operating conditions. For safety of personnel and for successful operations, it is essential to find the causes of such activation.

Main Power:	230 Volt compressor system - 60 amp on/off switch on power box, circuit breaker reset on starter boxes. The customer must have a licensed electrician hardwire this connection into a 230 Volt 60 amp service or greater. 120 Volt system – 15 amp circuit breaker controlling the outlet where the 120 V AC power is connected. It is preferable that the customer have an electrician hardwire this connection to a 120 15 amp service or greater.
Control Panel:	There is one 16 amp circuit breaker which protects the individual components from electrical hazards. These breakers should trip before the fuses on the individual pieces of equipment blow. To access these breakers, carefully open the control panel's cover.
Programmable Controller	The Controller has a 2.5 amp fuse inside the box behind the instrument panel. In the same location is a 9 Volt rechargeable Ni-Cad battery that retains the program's memory when the power is off.
Booster Pump:	A 16 amp circuit breaker inside the control panel (see "Control Panel" above) provides protection for the booster pump. The on/off switch is on the left side of the Control panel. This unit is hardwired into the Control Panel.
Ozone Generator:	A 16 amp circuit breaker inside the control panel (see "Control Panel" above) provides protection for the ozone generator. The KVA Model OZ-4 also has a 3 amp fuse inside the unit. To get access it is necessary to remove the cover plate. The fuse is below, near the middle. DANGER! Before removing cover, assure that the system is NOT powered, as there are high voltages internal to the ozone generator. The on/off switch is on the front of the unit, and the indicator light is lit when ozone is being produced. This unit is hardwired into Control Panel.

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

TABLE 2. (cont.) C-SPARGER™ SERIES 6000 LISTING OF SWITCHES, FUSES & BREAKERS

Oxygen Generator:	The 8 amp circuit breaker has an external reset that is by the on/off switch on the right side of the unit. This unit plugs into the 120 V outlet on the left side of the control panel.

Ozone Supply System

A booster pump delivers ozone from the ozone generator to a vertically mounted pressure tank. Figure 2 shows the details of the ozone generator The booster pump and ozone generator are controlled by the control panel switches according to the program entered into the programmable controller. The ozone generator and booster pump receive power from the control panel. In line between the ozone generator and booster pump is a PVC pressure tube to prevent back-pressure on the ozone generator. Operational maximum for air temperature is 40°C, and for humidity - 85%.

The ozone generator manufactures low concentrations of ozone, which is maintained within the closed system. Never the less, care should be exercised to avoid contact with the ozone should it escape for any reason. Ozone is recognizable by its pungent odor, and can collect in low lying stagnant areas. Exhaust fan ventilation should be supplied whenever the system is in operation. Protect the unit from dust and oils. See safety chapter for additional information.

The vertical pressure tank acts as a mixing chamber for the ozone and air from the compressor system. A pressure regulator and flow gauge determines the amount of air, which reaches the mixing tank, and its pressure. The pressure regulator is preset at KVA. A check valve prevents back flow of pressure from the mixing tank to the air tank. From the mixing tank an ozone/air gas mixture is supplied to the manifold. Solenoid valves on the manifold regulate the flow of gas to the Spargepoint® system.

Oxygen Generator

In certain situations an oxygen generator is supplied with the palletized system (Figure 3). Under humid conditions it dries the air before it reaches the ozone generator. The supply of oxygen to the ozone generator also increases the concentration of ozone supplied. The generator separates O_2 from the other gases found in air. The oxygen generator is able to run continuously. **Caution:** Oxygen promotes the rapid burning of combustible materials, and therefore due care should be exercised. Open flame or cigarettes should be extinguished before entering the area, and combustible materials should not be stored in the vicinity. See safety chapter for additional information.

Figure 2. Ozone Generator

Product Specification

Ozone Generation:	Silent pulse injection corona discharge
Process Gas:	Dry air or oxygen, free of dust And oil. Max. pressure +/-5psi.
Cooling:	Ambient air +/- 40°C max 85% RH
Power:	100-120V/60Hz, 120W
Dimensions	17" x 10" x 5"
Safety:	Aminimum air flow is not required. This unit is protected against voltage Surges and continuous 150% overvoltage

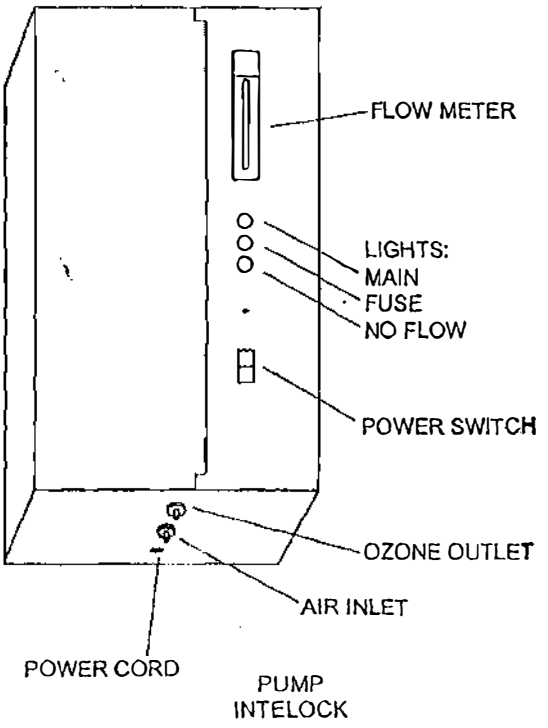
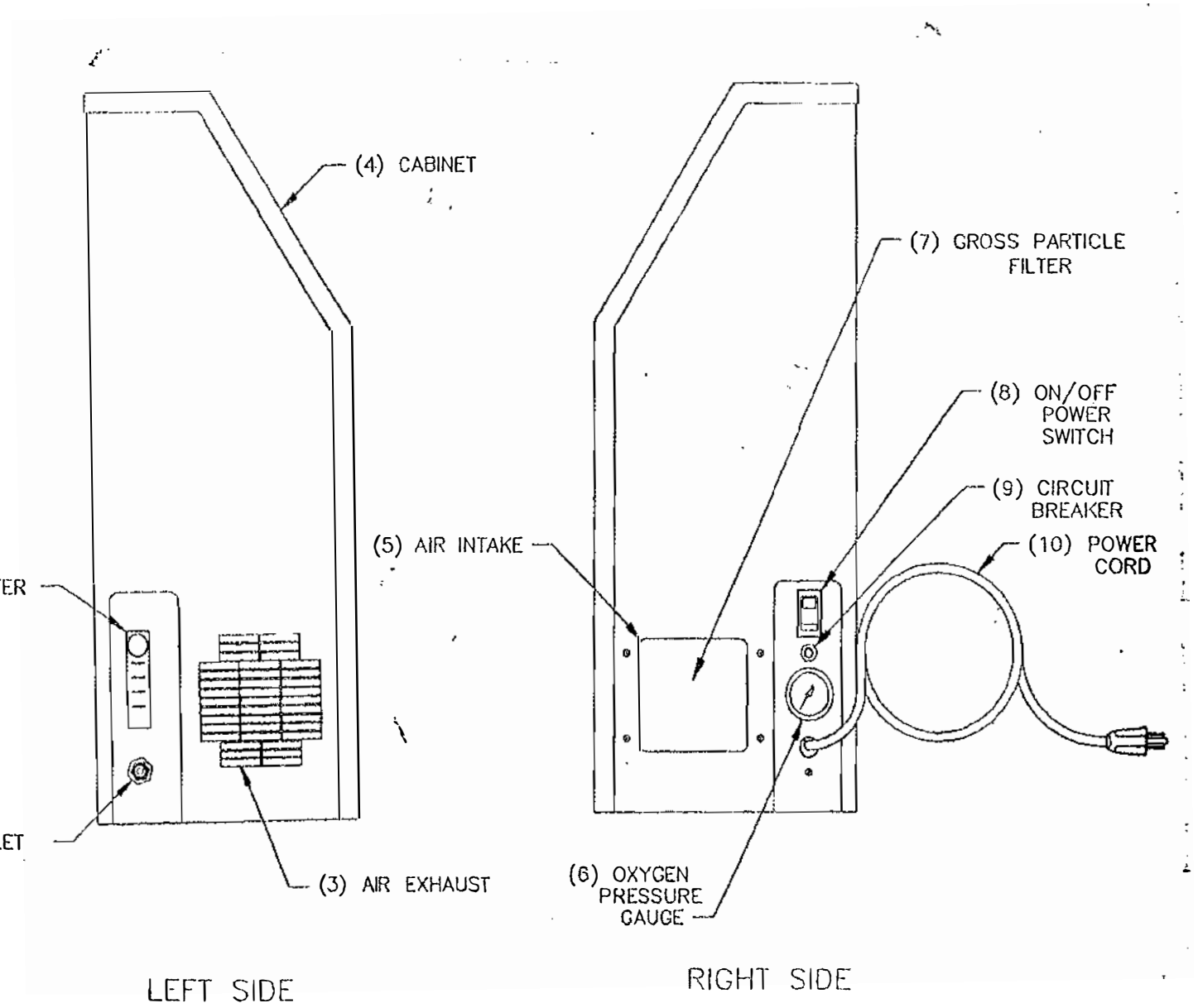


Figure 3. Oxygen Generator



DISTRIBUTION SYSTEM

Air and ozone flow from the C-Sparger™ to the Spargepoints® in the treatment wells via the Above Ground Well Head Assemblies (Figure 4)

Above Ground Well Head Assembly

Wellhead assemblies regulate air/ozone flow to each individual spargepoint®. They consist of a flowmeter, pressure gauge and appropriate fittings. Their purpose is to ensure that the flow of the air/ozone mixture is being supplied in equal amounts to all lines that are split from the solenoid valves. These assemblies have been successfully deployed in benign and moderate environments for prolonged periods of time. However, for severe environments (cold, hot, or wet), or where the threat of vandalism is substantial, KVA strongly recommends deployment of the boxes in a sheltered/controlled environment along with burial of power and air lines. Ozone and air are supplied under pressure through these boxes, and due care should be exercised (See safety chapter).

Spargepoints®

Spargepoints® diffuse micro bubbles of ozone/air into the surrounding soil and water. The Spargepoints are supplied ozone/air via ½" ozone resistant tubing from the palletized system to the ¾" PVC pipe at the well.

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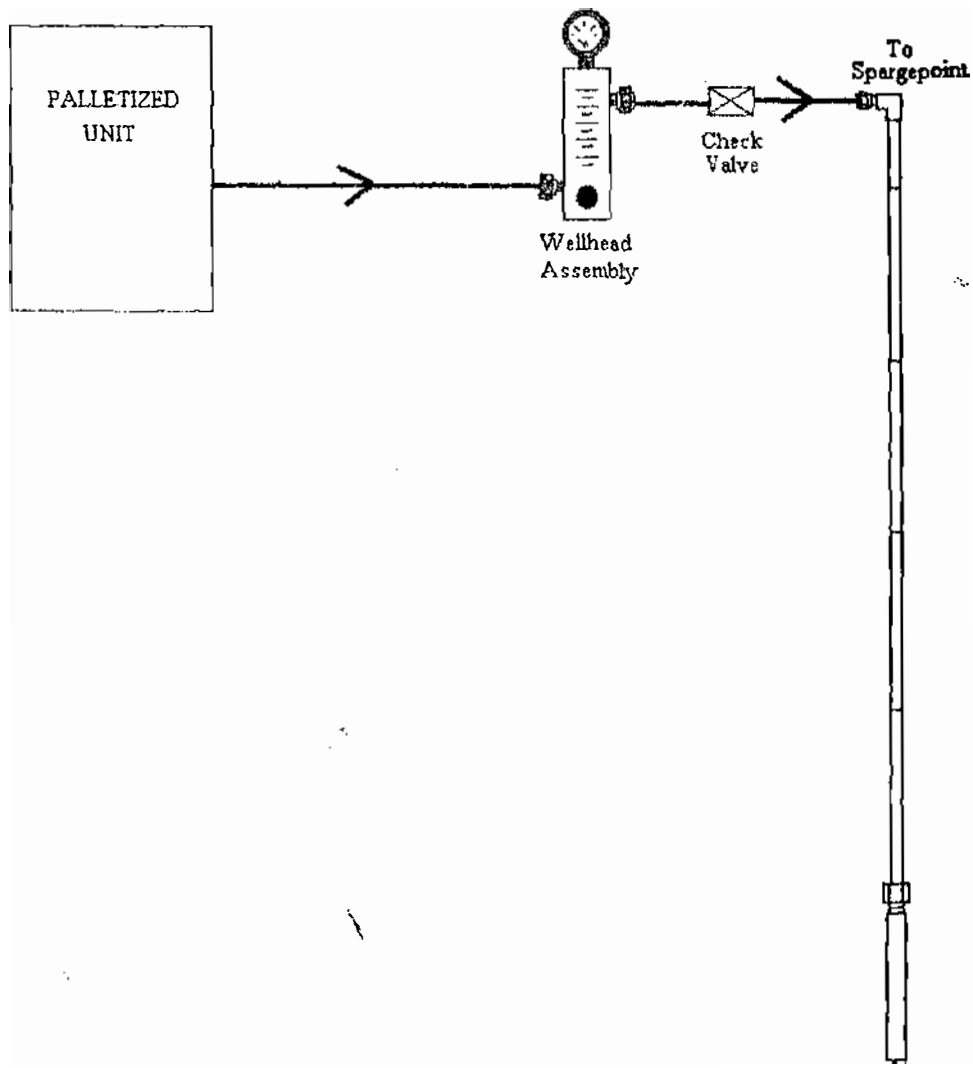
Figure 4. Air/Ozone Flow Schematic from C-Sparger™ to Spargerpoints®



INSTALLATION

PALLETIZED OZONE SUPPLY SYSTEM

Placement and safety considerations

The system must be housed in a dry and well-ventilated enclosed space. The C-Sparger™ unit should be bolted to a concrete slab. Ventilation should be provided by an exhaust fan that gives at least 2 exchanges per hour. A sufficient area must be provided around the unit for access, maintenance and heat dissipation. Normal operating temperature should be below 100° F. Prolonged operations above 100° F are detrimental to the longevity and proper operations of the equipment and are not recommended. After unpacking, check for any signs of damage. During shipment some fittings may have loosened. Check that all fittings are tight.

The C-Sparger™ is not designed for operation in explosive environments. Combustible materials should not be used or stored near the system while it is in operation. The ozone generator manufactures low concentrations of ozone, which is maintained within the closed system. Never the less, care should be exercised to avoid contact with the ozone should it escape for any reason. Ozone is recognizable by its pungent odor, and can collect in low-lying stagnant areas. Exhaust fan ventilation should be supplied whenever the system is in operation. The pallet is also supplied with an oxygen generator. Oxygen promotes the rapid burning of combustible materials, and therefore due care should be exercised. Open flame or cigarettes should be extinguished before entering the area, and combustible materials should not be stored in the vicinity. See the safety chapter in this manual for additional information.

Oxygen Generator

The oxygen generator should be mounted on a wall in close proximity to the C-Sparger™ pallet. The oxygen generator can plug into the 120 V outlet on the pallet, A 3/8 " tube supplied with the unit should be attached from the oxygen generator outlet to the ozone generator inlet. There is an opening in the line through a Tee fitting which allows for variation in line pressure (optional).

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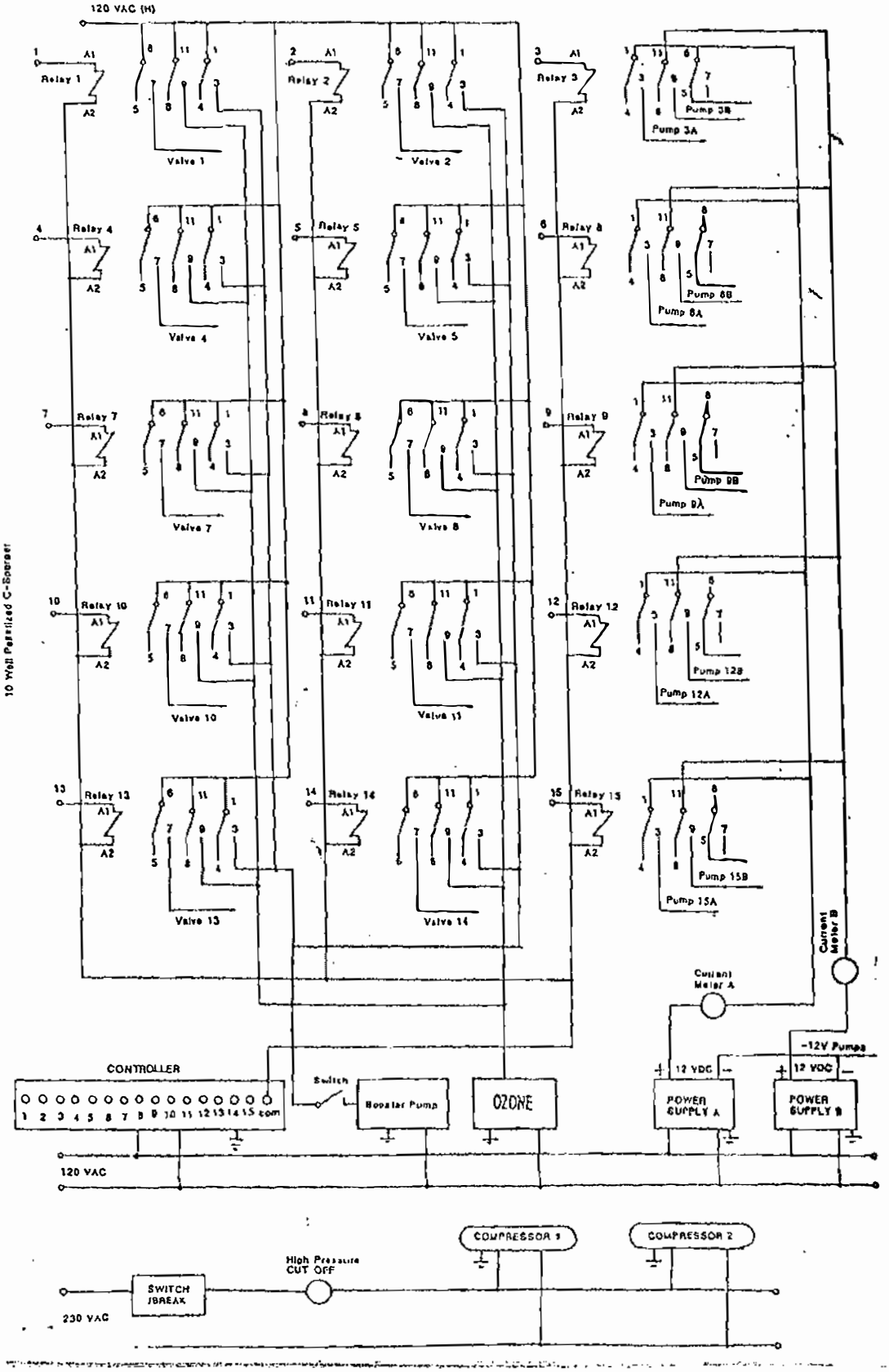
Electrical connections

A wiring schematic of the C-Sparger™ Model 6000 is given in Figure 5. Initially the palletized system is shipped with all switches in the OFF position. Any hardwiring to electrical power sources should be made while these switches are off in order to prevent surges damaging the equipment.

The palletized system has two electrical connections. One is a 230 Volt 60 amp single phase, which runs the compressors. The other connection supplies all other equipment and can be plugged into a 120 V 15 amp electrical outlet (or hardwired into a circuit box). It supplies power to the control panel, programmable controller, ozone generator and booster pump, and oxygen generator, through an electrical outlet box on the pallet.

WARNING: The palletized ozone supply system operates on 230 volt single phase and 120 volt power supplies. A licensed electrician must provide power hookups from suitable sources. The single-phase power must be hooked up correctly to avoid backwards movement of the compressor rotor — even momentarily. Only touch live ends for an instant to check direction of rotation before hook-up.

Figure 5. Wiring Schematic for the C-Sparger™ Model 6000 Series



Programmable Controller Settings

The controller is capable of operating up to 16 stations (switches) in each of four programs. Each program can direct up to six start times and durations per day.

Additional information can be found in the Programmable Controller's manual shipped with the unit. Note: If the reading USED is found in the LED window, it means the station is already being used in another program. The same station can be used in different programs, and assigned different start times and durations.

Step 1: Check that the time and date are correct. If a change is required rotate the dial to TIME/CALENDER. Use the MAN START/ADV key to advance between functions and the arrow keys to change the time and date where the LED display flashes. Return the dial to AUTO.

Step 2: Select a program. While the dial is in AUTO mode press the PGM key until the desired program letter (A,B,C or D) appears in the left side of the LED window.

Step 3: Select a cycle mode. For the purposes of this application a CUSTOM setting should be selected. CUSTOM will show in the LED window.

Step 4: Select an operation time for each station. Rotate the dial to each station, notice that there is a switch to change between stations 1-8 and 9-16. Make sure the desired program is selected. Adjust the time with the arrow keys. Leave unused stations at 0. Numbers on the right side of the colon indicate time in minutes.

Step 5: Set the start times. Six start times per program per day are available on the quarter hour. Set dial to WATERING START TIME. Make sure the desired program is selected. Toggle between the start time number and the start time with the MAN START/ADV key, while adjusting each with the arrow keys. Return the dial to AUTO.

FIELD INSTALLATIONS

Spargepoints®

Spargepoints® are usually supplied before the system. A drilling company should install the spargepoints® according to the proper installation instructions provided from KVA. Below are the basic installation instructions for sparge only wells. Figure 6 shows a basic spargepoint® installation and connections. KVA should supply you with your site specific installation, if you do not receive one please contact KVA.

1. Drill a 6" auger boring to desired depth.
2. Attach the ½" tubing to the Spargepoint® making sure the connection is tight.
3. Using a 1" OR 1.5" trimmee pipe set the Spargepoint® at the bottom of the boring. Retract the tremmee pipe during installation.
4. Back fill around and 2 feet above the Spargepoint® with 60 mesh pack sugar sand.
5. Back fill with bentonite beads 3 feet above the sugar sand. Allow bentonite to set.
6. Back fill from the bentonite beads to 3' below grade with a grout mixture. 20% bentonite, 80% Portland cement. Making sure the mixture is well mixed, avoid and dry nodules, and is below 110°F when injected. To alleviate some of the heat created from the grout mixture, native sand can be added to the grout mixture.
7. The remaining should be filled with a drainable pea gravel.
8. The top of the well should be covered for protection with a road box or well cover.

Wellhead Assemblies

Wellhead assemblies can be installed in two different locations and is based on preference only. They can be instatlled in a manifold fashion to the right of the palletized system or at the individual well heads. If they are installed at the well heads they must be installed in a road box or in some protective shelter. Figure 7 shows these installations.

Figure 5. Spargepoint® Installation Diagram

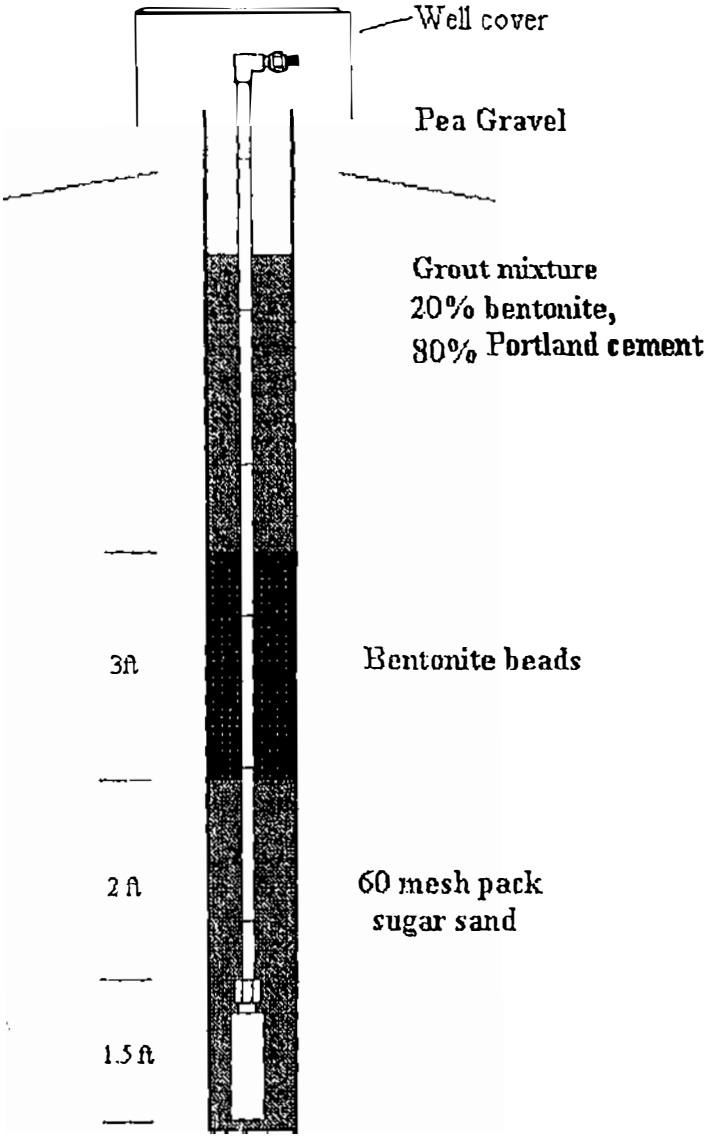
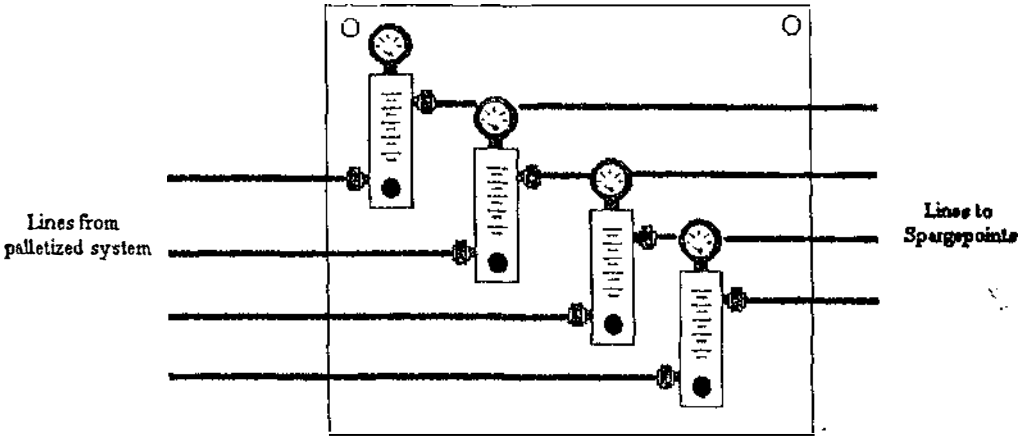
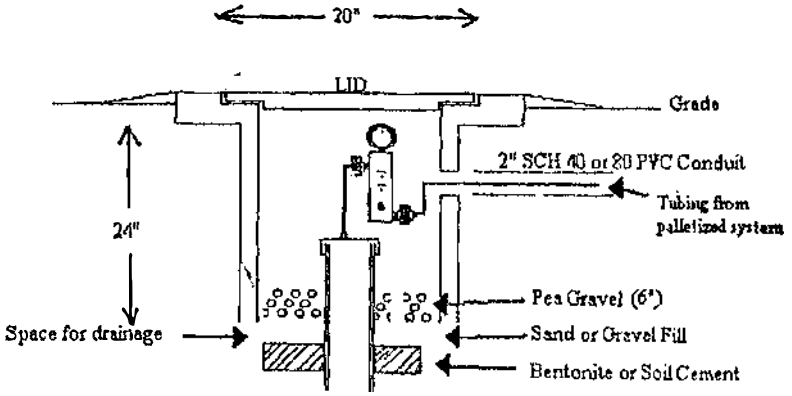


Figure 7. Wellhead Assembly installation diagrams

MANIFOLD MOUNTING



WELL HEAD MOUNTED



OPERATION AND MAINTENANCE

SYSTEM START-UP AND OPERATION

C-Sparger™ Model 6000 Series Palletized System

The following procedure is recommended for normal operation, as well as for initially testing the unit before tubing and electrical lines have been attached to the well assemblies.

1) In the enclosure that houses the palletized C-Sparger™ make sure the exhaust fan is on. The 220 V power should already be hardwired installed, and the circuit breaker on.

2) Before turning on 230 V power switch, open the drain valves on the bottoms of the air storage tank and the mixing tank (there may be lock fittings on these). Observe caution if there is already pressure in the tanks (read the tank pressure gauges first).

3) Check the air compressor function by turning on the 230 V power switch. The compressors should start instantly, and air should be coming out of both bleed valves. The compressors' magnetic starters contain circuit breakers (one for each pump) which may be re-set by pushing the button on the these boxes. For emergency shut-down, turn the master on/off switch to off. If for any reason the unit continues to blow fuses and requires circuit-breaker reset on a regular basis, a licensed electrician should be notified.

4) Turn off the bleed valve on the larger air tank first. Air should still be coming out of the mixing tank.

5) Close the bleed valve on the mixing tank. The pressure on both tanks should rise to a preset 45 psi, and then the compressors will turn off (when the pressure in the tank reaches approximately 25 psi the compressors will turn back on).

6) Open the bleed valve on the mixing tank again. Look at the gauge on the pressure regulator. It should read a preset 20 psi. This can be adjusted by turning the valve on the pressure regulator. The compressors will restart when the pressure gets down to 25 psi.

7) Plug in the C-Sparger™ pallet 120 V power into a suitable

8) Open the programmable controller's door and check the display. Change the time and date if necessary. See instructions in installation chapter. The dial should be turned to OFF at this point.

9) Plug the control panel into the 120 V electrical outlet on the pallet

10) If the air/ozone lines have been connected from the solenoid valves to the above well head assemblies in the field, then the oxygen generator can be turned on at the switch on the unit. A white light will indicate the unit is operational. A red light indicates a no flow condition, and ozone will not be generated. The ozone generator should only be turned on when the air/ozone output from the system vents to a well, or to outside space away from people. Make sure the exhaust fan is ON. If ozone is detected at any time immediately turn OFF the ozone generator at its switch, and clear the room if necessary. (See safety chapter in this manual).

11) Turn the dial in the programmable controller to station 1. Program A – Station 1 for 30 minutes should show in the LED display. Press the MAN. START key. Solenoid valve #1 should open. Note that pressures should drop on the air tank and mixing tank. To stop the program from running at any time turn the dial to off. There is a delay before everything turns off.

The booster pump will turn on automatically when a valve opens. The ozone generator will also turn on if it is switched ON. See step 10 above. If the valve is left open long enough the compressors will turn on when the pressure reaches 25 psi.

12) An abbreviated test of all stations can be achieved with the dial turned to TEST PROGRAM on the programmable controller. Set the length of time to test each station in program A for 1 to 99 minutes with the arrow keys. Press the MAN. START key. Station 1 (solenoid valve #1) will open as programmed. Turn the dial back to OFF when finished.

Set Up

After testing to be sure everything is operational the system needs to be set up. This will vary from site to site depending on the site characteristics. There are two ways that the system can be set up and that is on the high run time of the compressors and the low run time of the compressors. KVA recommends the low run time to save the compressors life.

The high run time of the compressors would be that whenever you are sparging in a line the compressors will be on constantly supplying maximum flow to the spargepoints®. This is done by adjusting the pressure regulator to be fully open, allowing all pressure in the tank to bleed out and opening the wellhead assembly fully.

The low run time of the compressors would be that when you are sparging in a line the compressors will build up enough pressure in the tank that they will shut off and only come on approximately twice in a 20 minute run time. To do this you must first adjust the wellhead assembly to about 1-2scfm. This will create a backpressure on the lines to the system. From there adjust the pressure regulator until the flowmeter reads about 3-6scfm.

If the system is set up somewhere in the middle of these the compressors will constantly be turning on and off. This is not good and the system should not be left to run like that.

Oxygen Generator

. If testing the oxygen generator (Figure 3) for the first time, or after prolonged

disuse, disconnect the oxygen generator from the ozone generator before testing. The oxygen generator is turned on for continuous use after all other components of the palletized C-Sparger™ system have been tested and are operational.

1. Plug in the power cord of the unit on the pallet 120 V outlet and place the ON/OFF power switch to the "ON" position.

   a. Make sure the gross particle filter is positioned.

   b. Make sure ON/OFF power switch is lit.

   c. Listen for the sound of the compressor running.

   d. Check to see that exhaust air is flowing out of the right side of the unit.

2. Turn the flow meter knob fully clockwise and observe that a zero flow is indicated. Then turn the flow meter knob counter-clockwise until it stops (wide open). The flow meter ball should rise to the top of the flow meter when nothing is connected to the oxygen outlet and the Oxygen Pressure Gauge should read 9 psig.

The oxygen generator has been preset to discharge at a pressure of 9 psig. The flow meter should be adjusted to 50%. The generator should only be operated between 40 and 100°F. If used continuously, it is recommended that the gross particle filter on the side of the unit be cleaned every two weeks.

Maintenance

Very little in the way of routine maintenance needs to be conducted for the C-Sparger™ Model 6000 series. Items included in the Maintenance Kit are listed in Table 5. The following maintenance should be carried out every two weeks, if the unit is operated continuously..

1. Spray a non-oil lubricant (such as CP Fluoroglide) onto the piston head and rings of the Booster Pump. Remove the head plate first to expose the piston head. **Danger: Be sure all power, both 120 V and 230 V, to the C-Sparger™ system is turned OFF at its source.**

2. The condensate can be blown from the bottom of the pressure tanks. The water and air/ozone mixture should be vented to outside. Any liquid should be captured for evaporation. **Caution: The mixing tank could have ozone inside it. The contents of the mixing tank should be bled outside away from people.**

3. On the oxygen generator, the gross particle filter at the air intake should be cleaned.

Table 3. Solenoid Valve Trouble Shooting	
PROBLEM	PROCEDURE
Valve fails to operate.	1. Check electrical supply with voltmeter. Voltage must agree with nameplate rating 2. Check coil with ohmmeter for shorted or open coil. 3. Make sure that pressure complies with nameplate rating.
Valve is sluggish or inoperative - electrical supply and pressure check out.	1. Disassemble valve as per the Disassembly Instructions. 2. Check the diaphragm for tears and for clogged or obstructed bleed hole or pilot orifice. A torn diaphragm must be replaced. 3. Check all springs. Replace if broken. 4. Check that the plunger is attached to the diaphragm assembly.
External leakage at sleeve flange to cover joint.	1. Check that sleeve is torqued with 130 - 150 in-lbs. 2. If leakage persists, remove sleeve and check flange seal for damage. Replace if defective.
External leakage at flange joint between body and cover.	1. Check that cover screws are torqued with an input torque of 65-85 in-lbs. If leakage persists replacement of diaphragm assembly or flange O-ring may be required and/or bodies or covers with damaged sealing surfaces may have to be replaced.
Internal leakage	1. Disassemble valve as per the Disassembly Instructions. Remove extraneous matter. Clean parts in a mild soap and water solution. 2. Examine surface of the plunger seal, diaphragm sealing surface for dirt. Remove all dirt. Examine pilot orifice and main orifice for nicks. Damaged parts must be repaired or replaced. 3. Check all springs. Replace if broken.

SAFETY

OZONE GENERATOR

Ozone (0_3) is the triatomic, allotropic form of oxygen (0_2). Ozone is an unstable gas with a pungent odor. Since ozone is unstable, it must be generated at the point of application. The ozone generator creates ozone by pulsed injection corona discharge across a dielectric tube. As air is passed through this high voltage tube, a few of the oxygen molecules become separated into single atoms that reattach themselves to other oxygen molecules creating ozone. Ozone can typically be detected in air by the human nose in concentration range of 0.02 to 0.05 ppm. However, some individuals (like cigarette smokers, others with breathing problems, and/or a person who works around hazardous materials which give off strong odors) may not be able to detect ozone concentrations this low.

Toxicity of Ozone

The toxicity of ozone is influenced by many factors, including the exposure concentration, the duration of exposure, whether the individual is at rest or active during exposure, and the susceptibility of the individual. In general, exposure to concentrations greater than 0.1 parts ozone per million parts of air (ppm) may result in effects to the respiratory system, such as dryness or irritation to the throat and nose, feeling of pain or congestion in the chest, wheezing, and cough. These symptoms are more likely to occur as concentrations exceed 0.3 ppm for 30 minutes, particularly in active individuals. Irritation to the eyes, headache, nausea, and alterations of pulmonary function may also occur. Concentrations greater than 0.9 ppm have been reported to result in sleepiness as well as more severe respiratory effects. Concentrations ranging above 9 ppm have been found to result in pneumonia. Unconsciousness has been reported following exposure to concentrations ranging up to 11.2 ppm over 2 hours. Based on animal experiments, exposure to 50 ppm for 1 hour could be fatal. The U.S. has set a threshold limit value for occupational exposure to ozone in the workplace at 0.1 ppm as a time-weighted average over an 8-hourday. The C-Sparger™ unit should not be installed in confined spaces. Outdoor installations shall not exceed 1.5 ppm ozone to remain in compliance with OSHA standards

AS FAR AS CURRENT SAFETY STANDARDS SET IN THE UNITED STATES, YOUR OZONE UNIT SHOULD NOT BE OPERATED ABOVE TRACE LEVELS.

It is strongly recommended that an electronic ozone detector be used to test the concentration of ozone inside the C-Sparger™ enclosure before entering the building. A detector is also useful when working for prolonged periods of time in close proximity to the operating C-Sparger™.

2 HP COMPRESSOR (Continuous Service)

Read and understand the following information and instructions before using. This information is for your safety and the prevent product damage.

1) To reduce risk of electrical shock:

   A) Do not disassemble. Disassembly or attempted repairs if accomplished incorrectly can create electrical shock hazard.

2) To reduce risk of electrocution:

   A) Do not use this product in or near area where it can fall or be pulled into water or other liquids.
   B) Do not reach for this product if it has fallen into liquid. Unplug immediately.

3) To reduce risk of explosion or fire:

   A) Do not use this product in or near explosive atmospheres or where aerosol (spray) products are being used.
   B) Do not pump combustible liquids or vapors with this product or use in or near an area where flammable or explosive liquids or vapors may exist.
   C) Do not use this product near flames.

4) To prevent injury:

   A) Never allow children to operate the unit.
   B) Never operate this product if it has a damaged cord, if it is not working properly, if it has been dropped or damaged, or if it has failed into water.
   C) Never block any air openings (inlet) of this product. Keep all air openings free of lint, dirt and other foreign objects.

   D) Never drop or insert fingers or any other object into any openings.

   E) Do not operate this product where oxygen is being administered.

   F) This unit may be thermally protected and can automatically restart when the protector resets. Always disconnect power source before servicing.

   G) Use only in well-ventilated areas.

   H) All electrical products generate heat. To avoid serious burns never touch unit during or immediately after operation.

OXYGEN GENERATOR

Oxygen is a fire hazard. It is very dangerous and vigorously accelerates the burning of combustible materials. To avoid fire and/or explosion, oil, grease, cotton fibers and any other combustible material must not be used on or near the oxygen generator. Smoking, heat and any open flame should be kept at a distance of no less than 5 feet from any part of the system. It is STRONGLY recommended that only individuals experienced or trained in the safe handling of oxygen be allowed to operate this equipment.

Do not use extension cords with this unit and connect power cord only to properly grounded wall outlet.

LIABILITY AND WARRANTY

LIMITATION OF LIABILITY

The manufacturer shall not under any circumstances be liable for special or consequential damages, such as, but not limited to, damage or loss of property or equipment, loss of profits or revenue, cost of capital, cost of purchased or replacement goods, or claims of customers or Purchaser for service interruption. Any property damage or personal injury resulting from this product, which contains replacement parts or accessories that affect the safety or performance of such product, shall be the responsibility of the Purchaser and the supplier of such replacement parts or accessories and not the responsibility of the manufacturer. The remedies of Purchaser set forth therein are exclusive, and the liability of the manufacturer with respect to any contract, or anything done in connection therewith such as the performance or breach thereof, or from the manufacture, sale, delivery, resale, or use of any goods covered by or furnished by the manufacturer whether arising out of contract, negligence, strict tort or under any warranty, or otherwise, shall not, except as expressly provided herein, exceed the price of goods upon which such liability is based.

LIMITED WARRANTY

This product is warranted to be free of defects in workmanship or material for six months. Except if the in-well pump shall prove to be inoperable upon receipt, the in-well pumps are excluded from this warranty. Except the in-well packer, which shall have a three-month warranty. The use of any product with replacement parts or accessories, which are not manufactured or distributed by the manufacturer and which affect product safety or performance, shall render this warranty and all other warranties, whether express or implied, null and void. Should any failure to conform to this warranty appear within six months after initial sale, the manufacturer shall, upon notification thereof and substantiation that the product has been maintained, correct such defects by suitable repair or replacement at its own expense, Purchaser being responsible for shipping charges only.

This warranty is exclusive and in lieu of any warranty or merchantability, fitness for particular purpose or other warranty of quality, whether express or implied, except of title and against patent infringement. Correction of nonconformities, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the manufacturer to the Purchaser with respect to, or arising out of this product, whether based on contract, negligence, strict tort or otherwise.

APPENDIX B

MAINTENANCE SCHEDULE

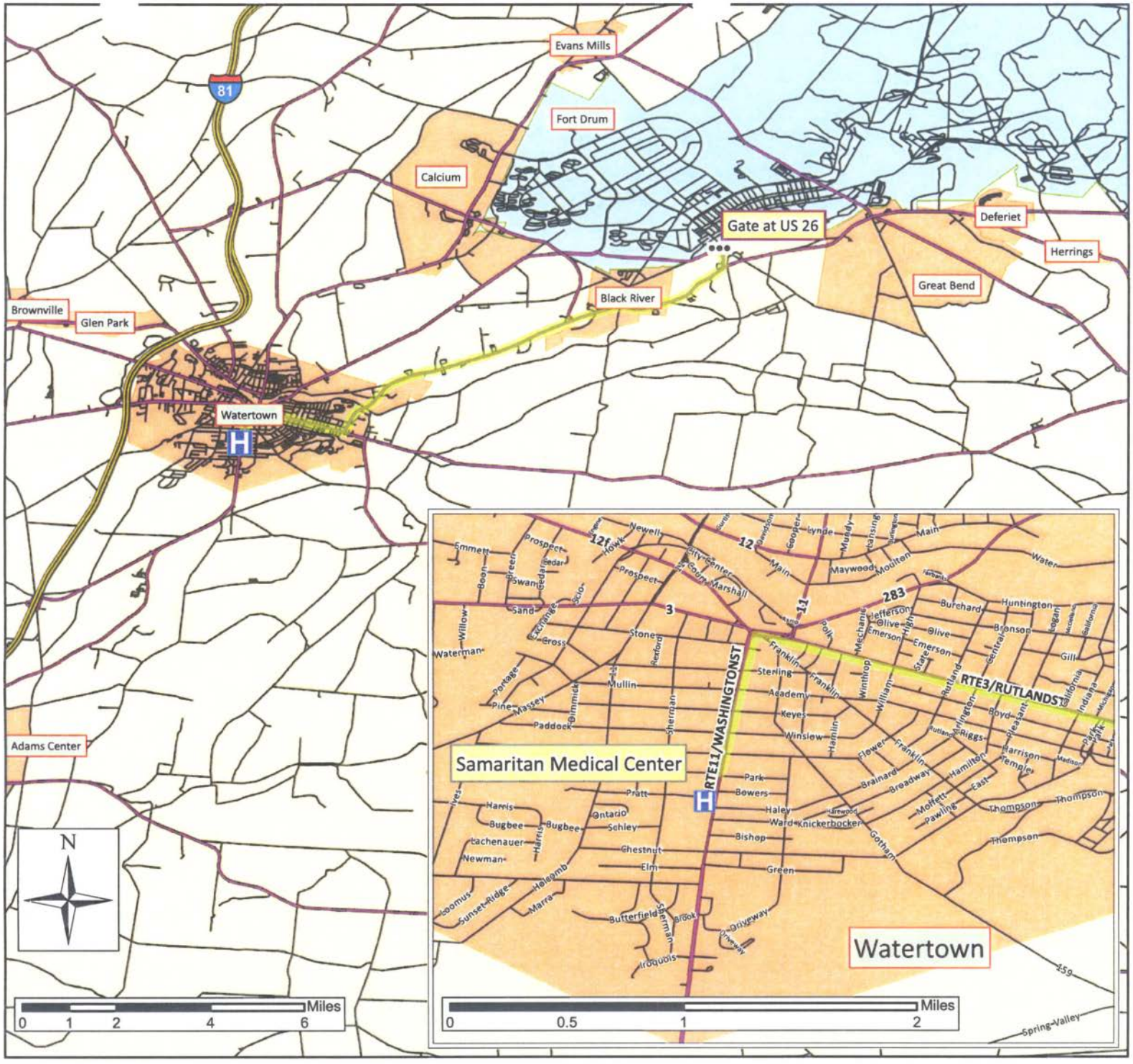
MAINTENANCE SCHEDULE

The following maintenance should be carried out every two weeks, if the unit is operated continuously.

1. **Be certain all power, both 120V and 230V, to the C-Sparger™ system is turned OFF at its source before proceeding.** Remove the head plate to expose the piston head. Spray a non-oil lubricant (i.e. CP Fluoroglide) onto the piston head and rings of the Booster Pump.
2. Blow the condensate from the bottom of the pressure tanks. The water and the air/ozone mixture should be vented to the outside. Any liquid should be captured for evaporation. **Caution: The mixing tank could have ozone inside it. The contents of the mixing tank should be bled outside, away from people**.
3. Clean the gross particle filter at the air intake on the oxygen generator.

APPENDIX C

MAP TO HOSPITAL
AND
EMERGENCY CONTACT LIST



Map Key

- Gate
- Hospital
- Hospital Route
- Major Highway &Interstate Connector
- Main Thoroughfare & State Highway
- Tertiary Roads
- Ft Drum Boundary
- City Limits

4501 Ford Ave.
Suite 1200
Alexandria, VA 22302
(P) 703.820.3339
(F) 703.845.8568

Created By: Alex Scott
Date: September 11, 2008

Hospital Route for Fort Drum

Health and Safety Plan For Remedial Action Operations and Long-Term Management at Designated Sites

EMERGENCY CONTACT LIST

Medical Emergencies: Ft. Drum Communications Center	Cell phone outside the 315 Area Code: (315) 772-5156 or 5157 Cell phone inside 315 Area Code: *766 Land lines other than Fort Drum 772 exchange: 911
Police Department: Ft. Drum Communications Center	Cell phone outside the 315 Area Code: (315) 772-5156 or 5157 Cell phone inside 315 Area Code: *766 Land lines other than Fort Drum 772 exchange: 911
Off-Base Medical Facility: Samaritan Medical Center 830 Washington Street, Watertown, NY	(315) 785-8469
Fire Emergencies: Fort Drum Communications Center	Cell phone outside the 315 Area Code: (315) 772-5156 or 5157 Cell phone inside 315 Area Code: *766 Land lines other than Fort Drum 772 exchange: 911
Fort Drum Range Control (for potential UXO emergencies)	(315) 772-0879
Poison Control Center	(800) 222-1222
Federal OSHA Hotline	(800) 321-6742
Nat. Weather Svc. Forecast Office – Albany www.erh.noaa.gov/er/aly Birmingham Office Telephone Contact	(607) 770-9531
COR: Mr. Scott Weber USAEC ERM and COR	(410) 436-1614
Fort Drum IRP Manager: Mr. Don Beevers	(315) 772-4211
Fort Drum Chief of Compliance: Mr. Paul Zang	(315) 772-5063
Plexus Program Manager: Mr. Jeff Sgambato	(410) 715-3865, ext.123 Cell: (504) 723-4523
Plexus Project Manager: Mr. Greg Kendall	(703) 820-3339, ext. 152 Cell: (202) 253-8299
Plexus Health and Safety Coordinator: Ms. Margaret Mikulich	(410) 715-3865, ext. 111 Home Office: (301) 515-9115 Cell: (301) 908-3639
Plexus Task Manager: Adam Gregory	(410) 715-3865, ext. 109
Plexus Health and Safety Officer: TBD	TBD

APPENDIX D

SIGN IN SHEETS

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)

SIGN IN SHEET

Name	Company	Date	Time (In/Out)